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THESIS

**WORKFLOW REENGINEERING:
A METHODOLOGY FOR
BUSINESS PROCESS REENGINEERING
WITH WORKFLOW MANAGEMENT
TECHNOLOGY**

by

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September 1995

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WORKFLOW REENGINEERING: A METHODOLOGY FOR BUSINESS PROCESS REENGINEERING WITH WORKFLOW MANAGEMENT TECHNOLOGY

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All organizations, both private and public, must improve their business practices to survive in today's volatile and highly competitive marketplace. This thesis overviews business process reengineering principles, and examines four methodologies for its accomplishment. Based on existing approaches, the thesis develops a new reengineering procedure, called the Workflow Reengineering Methodology. This methodology uses workflow automation as an enabler for efficiently and effectively conducting reengineering. The proposed methodology consists of five phases and 32 component steps with associated data collection forms. The thesis also includes a case study of the application of a portion of the methodology using workflow data gathered from the Port Hueneme Division of the Naval Surface Warfare Center. The methodology and its data collection forms significantly streamlined the capture of process data, and facilitated the generation and analysis of workflow design alternatives. The proposed Workflow Reengineering Methodology promises to be a methodology that can be used with supporting workflow automation to improve an organization's business processes.

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I. INTRODUCTION

This chapter provides introductory information on the purpose for, and content of, the thesis. It discusses the background and objectives of the research, the questions answered and the methodology used. It delimits the scope of the thesis, and defines incorporated abbreviations and key words. Finally, it outlines the content of each of the included chapters.

A. BACKGROUND

American companies and government agencies alike are striving to improve, streamline, and automate their business practices to adjust to the rigorous demands of a highly volatile marketplace, austere financial resources and manpower reductions. To be successful in today's rapidly changing business climate, an enterprise must ensure that its information infrastructure effectively supports and contributes to the efficiency of its business processes. A workflow management technology (workflow) is an approach that automates, integrates and manages work. It includes flexible process modeling and real-time status monitoring and performance measurement capabilities that can greatly assist an organization in reengineering its business processes.

The Port Hueneme Division of the Naval Surface Warfare Center (PHD NSWC) sponsored research into the most effective use of workflow management technology within their organization. The overall goal of the workflow project was to enable PHD NSWC to provide the fleet user with more timely logistical support as modifications to a particular weapon system or its supporting documentation unfold. Studies on the costs and benefits of workflow, the media available to deliver workflow capabilities to the users on ships at sea, and the required data object formats for electronic customer interactions were completed by other project team members in March 1995.

B. OBJECTIVES

The purpose of this research is to conduct a thorough study into structured methodologies available for enabling business process reengineering (BPR) through the use of workflow management automation. The author was unable to locate a single methodology, described in full detail, that provided step-by-step instruction on how to use workflow management tools to analyze and redesign business processes. Methodologies for workflow planning that include BPR exist, but they are proprietary in nature. DoD activities cannot afford to hire the costly consultants who possess these trademarked procedures, nor can they afford to ignore or haphazardly construct automated workflow plans without proper methods or tools. Therefore, it is imperative that a practical methodology for incorporating BPR into workflow analysis and design be developed and tested. The goal of this thesis, therefore, is to develop and test a comprehensive methodology for performing BPR using a workflow management tool.

C. RESEARCH QUESTIONS

This research was focused on the following questions:

- What is Business Process Reengineering (BPR) and what methodologies and tools exist for its enactment?
- What is workflow management and how is it supported by information technology?
- What analysis and design methodologies exist for workflow design?
- Can workflow software enable BPR?
- How can a BPR methodology be incorporated into workflow analysis and design?
- If no appropriate methodologies exist for BPR and/or workflow, what would be a feasible structured methodology for the combination of workflow design and BPR?

D. SCOPE OF THESIS

This thesis includes an overview of BPR and workflow management. The author examines existing BPR methodologies, including a detailed description of the methodology prescribed by DoD. A methodology for enabling BPR with workflow management tools is presented. The proposed workflow/BPR methodology is then applied in a case study that includes the design and analysis of a workflow model for PHD NSWC.

E. RESEARCH METHODOLOGY

The research techniques used for this thesis included a thorough literature review of the following topics: Business Process Reengineering, Functional Process Improvement, Workflow Management Technologies, and Workflow Management Design Methodologies. The author also attended a two-day workflow seminar, sponsored by a leading workflow consulting firm, and three workflow management product exhibitions. Personal and telephone interviews were conducted with subject area experts and PHD NSWC staff.

The proposed Workflow Reengineering Methodology was synthesized from applicable portions of BPR and workflow design methodologies discovered during the literature review. To complete the methodology, the author developed and incorporated additional procedures for vague or lacking segments of the workflow design and reengineering methods.

F. ABBREVIATIONS AND DEFINITIONS

1. Abbreviations

The following abbreviations are used throughout the thesis:

BPI	Business Process Improvement
BPR	Business Process Reengineering
CIM	Corporate Information Management

DoD	Department of Defense
FEA	Functional Economic Analysis
FPI	Functional Process Improvement
IT	Information Technology
NPR	National Performance Review
PHD NSWC	Port Hueneme Division, Naval Surface Warfare Center
SECDEF	Secretary of Defense

2. Definitions

The definitions of terms used in the thesis are as follows:

- ***Business Process Reengineering:*** The rudimentary rethinking and "...redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed" (Hammer and Champy, 1993).
- ***Corporate Information Management:*** A DoD initiative that requires the examination and viable restructuring of all business processes throughout the department. The premise of the program is that the implementation of improved processes which: (1) are enabled by technology; (2) substantially increase productivity; (3) decrease costs; and (4) do not sacrifice quality. (*A Plan for Corporate Information Management....*, 1993)
- ***Functional Economic Analysis:*** An approach used in a Functional Process Improvement initiative to provide supporting documentation for the costs and benefits of proposed process improvements and the required information infrastructure investment. (*Functional Economic Analysis Guidebook*, 1993)
- ***Functional Process Improvement:*** DoD's version of BPR which has five key objectives: (1) reduce the cost of doing business by eliminating unproductive procedures and regulations; (2) improve productivity, quality and customer service; (3) begin fee-for-service operations; (4) create an environment of continuous process improvement; and (5) empower command leaders to improve their business practices and make them directly accountable for the success or failure of their organizations. (DODINST 8020.1-M, 1993)
- ***National Performance Review:*** An intensive study of the federal government's operating procedures and regulations. The goal of the review is to create a government that costs less and provides quality services to the American taxpayers. (Gore, 1993)

- ***Workflow:*** An ordered collection of tasks that, when linked together, form a business cycle of an organization. (Marshak, *The Workflow Paradigm*, 1994)
- ***Workflow Management Software:*** A computer application that enables the electronic transfer and management of information and work throughout an organization's business processes using pre-defined rule-based routing and client-server technology. (Koulopoulos, 1995)

G. CHAPTER OUTLINE

This thesis is organized as follows. Chapter II provides an overview of BPR fundamentals and principles, and examines three available methodologies for its accomplishment. Chapter III delineates the Functional Process Improvement methodology and tools that DoD uses to conduct BPR. Chapter IV provides an overview of workflow management software technologies and identifies a partial procedure for workflow template design. Chapter V contains a proposed workflow design methodology that was created to enable BPR through the use of automated workflow management tools. Chapter VI includes a case study of the application of a portion of the proposed workflow/BPR methodology using a workflow example from PHD NSWC. Chapter VII includes an analysis of the proposed methodology and suggestions for future research.

II. BUSINESS PROCESS REENGINEERING

This chapter provides an overview of business process reengineering concepts. It begins with a discussion of the background of, and need for, BPR. Next, it defines the categories, ideals and principles of reengineering, and identifies the participants of the reengineering process. The subsequent section presents the steps of three BPR methodologies presently found in literature. Finally, it includes an analysis of the completeness, ease of use and adequacy of supporting tools for each of the discussed methodologies.

A. BACKGROUND

In 1776, Adam Smith, an economist and philosopher, published *The Wealth of Nations*. In this book he wrote that, to realize immense improvements in business production, an organization should analyze the work being performed within its boundaries and break it down into its simplest components. These tasks should then be divided between employees, each of whom performs a single function or a set of simple tasks. As a result of this division of labor, centralized and hierarchical bureaucracies are established to control the flow and manage the completion of work steps across an organization. (Hammer and Champy, 1993)

Smith's tenets of industrial management revolutionized industry. His management methods have been successfully practiced by American businesses for over 200 years. As a result, American companies have led the world in manufacturing productivity and have succeeded in meeting the expanding global customer demand for high-quality products and services. (Hammer and Champy, 1993)

In his writings, Smith identified three organizational assets that must be effectively managed if a business is to be successful: capital, material and people. The rampant success enjoyed by American companies during the Industrial Age also demanded the management of increased amounts of data concerning product lines, resources, customers

and employees. Consequently, information became a fourth resource to be managed. "Just as capital, material, and people need to be managed in order to achieve effectiveness and efficiency, so does information" (*A Plan for Corporate Information Management....*, 1993).

The information revolution was spurred by the development and use of high speed computing and world-wide communications. Information systems were built to support the specialized work and requirements of functional entities within an organization.

> Most U.S. government agencies and corporations viewed information management as the automation of existing business methods in order to reduce costs. With this narrow view, little effort was made to improve the methods themselves. Results were disappointing: new technology applied to old methods did not produce the benefits expected. (*A Plan for Corporate Information Management....*, 1993)

These information systems were often independently constructed and, as a result, could not be integrated. Due to this lack of inter-operability and the automation of obsolete procedures, the country's immense investment in computer system infrastructure did not produce the net gains in productivity necessary to recoup its costs. "The result has been a net productivity gain in the white-collar work force of less than one percent over twenty years" (Koulopoulos, 1995).

The Information Age, with its use of expedient communications, has produced a highly competitive and volatile global marketplace in which American businesses that once dominated the market are now struggling to compete:

> Advanced technologies, the disappearance of boundaries between national markets, and the altered expectations of customers who now have more choices than ever before have combined to make the goals, methods, and basic organizing principles of the classical American corporation sadly obsolete. Renewing their competitive capabilities isn't an issue of getting the people in these companies to work harder, but of learning to work differently. (Hammer and Champy, 1993)

To ensure their continued existence within this dynamic marketplace, American companies are seeking more innovative and efficient ways of doing business. Present methods of operation, and the information systems that have been built to support them, are being critically analyzed for efficiency, flexibility and their value to the overall product or service of the company. Outdated business processes and systems are being redesigned to reflect new business goals and to improve corporate responsiveness to customer demands. (Hammer and Champy, 1993)

B. REENGINEERING OVERVIEW

There are various business process improvement initiatives discussed in today's literature: Business Process Reengineering, Process Innovation, Business Process Redesign, and Business Process Improvement, to name a few. Some of these methods promote radical change with no regard for past practices, while others take a more incremental approach to improving present processes. They all, however, share a common goal: the desire for dramatic improvements in business productivity and customer service. Due to their similarities, these initiatives can be grouped under the broad category of business process reengineering.

Webster's New World Dictionary defines engineering as "...the planning, designing, construction, etc. of machinery, roads, bridges, etc." (*Webster's New World Dictionary*, 1990). Reengineering is the redesigning or rebuilding of an item or activity. A business process is an aggregation of work steps that transfigure organizational inputs and resources into business products or services. Business process reengineering (BPR), therefore, is the rudimentary rethinking and "...redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed...(by) looking afresh at the work required to create a company's product or service and deliver value to the customer" (Hammer and Champy, 1993). The desired outcome of reengineering is a customer focused organization that experiences extraordinary gains in productivity and profitability.

1. Categories of Reengineering

The various methods of process improvement can be segregated into three categories of reengineering: crisis, goal oriented and life-cycle. Approximately 75% of process reengineering projects undertaken by companies are life-cycle or goal oriented in nature, and 25% are crisis related (Delphi Consulting Group, 1993). The method of reengineering selected often depends upon the level of senior management sponsorship within an organization and the level of risk that the organization is willing to incur to while improving its business processes. (Koulopoulos, 1995)

a. Crisis Reengineering

Crisis reengineering occurs when internal and/or external pressures mandate a change in business operations. The company must act or perish. This type of change effort is unlikely to involve any formal methodology since a lack of adequate planning probably precipitated the crisis event. Crisis reengineering does not require a sponsor because change is required regardless of the method or solution selected. (Koulopoulos, 1995)

b. Goal Oriented Reengineering

In goal oriented reengineering, new business objectives are envisioned that are substantially different from past or present goals. The strategy for change is to radically transform the processes of an organization by starting with a clean slate and devising how the company should conduct business in the future. In this method of reengineering, present processes and the historic ways of conducting business are completely ignored. This is the form of reengineering promoted by Hammer and Champy:

> To reinvent their companies, American managers must throw out their old notions about how businesses should be organized and run. They must abandon the organizational and operational principles and procedures they are now using and create entirely new ones. (Hammer and Champy, 1993)

Such a substantial transformation of business operations demands an executive level of organizational sponsorship due to the risk inherent in the obliteration of familiar business objectives and tactics, and the implementation of neoteric operating procedures. A detailed methodology and supporting tools are necessary to properly conduct the reengineering effort. A formal mission and vision statement that describes what the company desires to do or accomplish in the future must be devised to guide the focus of the reengineering team. (Koulopoulos, 1995)

c. Life-Cycle Reengineering

Life-cycle reengineering is strategic and ongoing. Businesses make incremental changes to perpetually alter their operational course of action. The reengineering effort includes a baseline assessment of how the company's work is presently being accomplished. Managers then use metrics to determine the value of each task and examine possible changes that will improve the process. Radical and/or conservative improvements to present processes are made where appropriate. Because there is no crisis spurring the innovation program, this type of reengineering requires a high level champion within the organization who can ensure the continuation of the improvement program, and the provision of adequate and continuous funding. (Koulopoulos, 1995)

Life-cycle reengineering has been referred to in literature as Business Process Improvement, Process Innovation and Business Process Redesign. It is the safest type of reengineering for organizations that do not possess the resources or the capacity necessary to assume the high level of risk inherent in obliterating existing business processes. It is also the type of business process reengineering that is best supported by the automated workflow management technologies that will be discussed in Chapter IV. Therefore, life-cycle reengineering is the category of reengineering that will be examined herein and that will hereafter be referred to as BPR.

2. Reengineering Ideals

Business process reengineering efforts are based upon a common set of ideals. Hammer and Champy list four themes that are preeminent in successful reengineering efforts (Hammer and Champy, 1993):

- Process orientation
- Ambition
- Rule-breaking
- Creative use of information technology

a. Process Orientation

The focus of management theory has shifted from work simplification and control in the Industrial Age, and information and its sharing in the Information Age, to processes and their improvement in the era of reengineering:

> Task-oriented jobs in today's world of customers, competition, and change are obsolete. Instead, companies must organize work around *process*. (Hammer and Champy, 1993)

A process is a business asset. It contains the corporate knowledge base of why, when, and how information, products and control are transferred within an organization (Koulopoulos, 1995). "Most companies, even very large and complex ones, can be broken down into fewer than 20 major processes" (Davenport, 1993). Figure 1 includes a listing of typical processes within a manufacturing business.

A single process may involve personnel from several different functional specialties within an organization. "Processes are the way work is done in organizations, and they typically cross many organizational boundaries, both because businesses are not self-sufficient (they have suppliers, subcontractors, partners and allies) and because most

Operational	**Management**
Product Development	Performance Monitoring
Customer Acquisition	Information Management
Customer Requirements Identification	Asset Management
Manufacturing	Human Resource Management
Integrated Logistics	Planning and Resource Allocation
Order Management	
Post-Sales Service	

Figure 1. Typical Processes in Manufacturing Firms, After Davenport, 1993

businesses are organized around functional specialties (finance, human resources, production, engineering, etc.)" (Klein, M., 1993).

To achieve significant improvements in productivity and quality, an entire process must be analyzed for efficiency, not just individual work steps contained within aparticular functional department of an organization. "Define a reengineering effort in terms of an organizational unit, and the effort is doomed" (Hammer and Champy, 1993). This is because each department only encompasses a fragment of the overall process. Change in only one component of a process, with no consideration for the process as a whole, could result in negative ripple effects that decrease the value of the overall process.

b. Ambition

Ambitious reengineering teams seek innovative ways to achieve marked improvements to the company's business processes. All business cycles within an organization are considered as possible candidates for reengineering. No area of the corporation is considered sacred or protected from possible change initiatives. (Hammer and Champy, 1993)

c. *Rule-Breaking*

Business rules are the established procedures within a company for conducting operations. Reengineering teams must not let existing rules limit their consideration of improvement alternatives. They should consider new ways of conducting business to significantly improve organizational productivity and market share. Rule-breaking requires a commitment by management to sever any historic relationships with old, well-established procedures that no longer are effective or efficient. (Hammer and Champy, 1993)

d. *Information Technology as Enabler of BPR*

Today's advanced information technology (IT) plays a significant role in BPR. Hammer and Champy call IT an "essential enabler" of reengineering. "Without information technology, the process could not be reengineered" (Hammer and Champy, 1993).

IT contributes to process improvement in numerous ways. Thomas H. Davenport, of Ernst & Young's Center for Information Technology and Strategy, specifies nine areas of wherein IT can assist with BPR (Davenport, 1993):

- **Automation:** IT can be used to automate tasks and, thereby, improve work quality, integrity and speed.
- **Information:** Electronic transfer of information and documents via telecommunication systems or networks decreases process completion time and facilitates enhanced work coordination.
- **Sequence:** IT, such as databases and groupware, allows parallel work accomplishment, thereby improving the sequencing of tasks and decreasing the overall business cycle time.
- **Tracking:** IT enables the close monitoring of process objects and their completion status.
- **Analysis:** The data manipulation, storage and presentation capabilities of IT allow for the critical analysis of processes and their supporting information.

- **Geography:** Telecommunications networks allow the sharing and transfer of information between geographically dispersed organizations.
- **Integration:** Database and groupware technologies allow multiple personnel to work together on a single project.
- **Intellect:** IT, such as expert systems, allow the capture and preservation of corporate knowledge and procedures.
- **Disintermediation:** Electronic data interchange decreases the requirement for person-to-person interactions and reduces the number of people involved in a process.

There are also IT tools that are specifically designed to support reengineering. "Over recent years, the convergence of several technologies and approaches, such as workflow, process mapping, information modeling, simulation, groupware, imaging, and knowledge management, has resulted in a broad range of new possibilities and an exciting generation of new tools for BPR" (Rock and Yu, 1994). These tools allow a reengineering team to (Rock and Yu, 1994):

- Capture, visualize, and monitor real-time, end-to-end processes
- Represent process rules and exceptions
- Dynamically re-plan and reschedule activities
- Simulate discrete events
- Analyze the tradeoffs in hypothetical scenarios of process redesign
- Proactively manage and learn from day-to-day events

3. Reengineering Principles

Hammer and Champy specify several characteristics that are typical of successfully reengineered processes. These attributes are easily transformed into reengineering principles that can be used as guidelines for a reengineering team (Hammer and Champy, 1993):

- Combine several jobs into one to involve fewer people in the completion of a process. This reduces the errors and delays caused when transferring work to other employees.
- Let the workers make decisions. This reduces the completion time of the process by cutting out vertical requests and responses within an organization.
- Perform the steps of a process in a natural order.
- Designate a person who will be responsible for controlling and improving each process.
- Create multiple versions of a process. Each version should be dependent upon a particular outcome of a decision made by the person performing the task.
- Perform work where it makes the most sense.
- Reduce checks and controls on work. Only perform tasks that add value to the overall process.
- Provide a single point of contact to business customers.

Russ Linden, of Russ Linden & Associates delineates additional principles to be followed when conducting BPR (Linden, 1993):

- Substitute parallel for sequential processes to decrease business cycle time.
- Capture information once, at the source.
- Bring "downstream" information "upstream" so that all required information for the entire process is gathered and entered into the system at the start. This will decrease data gathering and communication times.
- Ensure a continuous flow of value-adding activities. Get rid of tasks that do not produce something of value to the customer.
- Organize around outcomes, not functions. Ensure there is an important business reason for conducting a process or task.
- Redesign the process first, then automate. Do not automate first and simply speed up a faulty procedure.
- Know why a piece of paper enters the system. Substitute technological interfaces where face-to-face interactions are not required.

As a result of applying these principles when conducting BPR, Hammer and Champy envision the development of a new world of work wherein numerous aspects of the organization are transformed (Hammer and Champy, 1993):

- Jobs change from simple tasks to multi-dimensional work as workers take on a larger portion of the overall process. Work that was once segmented into its basic components during the Industrial Age is rejoined when a single person or team becomes responsible for completing the entire process.
- Organizational structures change from hierarchical to flat as work units change from functional departments to process teams with greater autonomy and a decreased requirement for supervision.
- Managers change from supervisors to coaches as their emphasis shifts from oversight and control to becoming a facilitator, enabler and educator.
- Executives change from scorekeepers to leaders as they move closer to their customers and front-line process teams.
- Values change from protective to productive as employees begin to work together to provide a higher quality of service or product to their customers.
- People's roles change from controlled to empowered as they are given the responsibility to perform, improve operations and make decisions.
- Job preparation changes from training to education. Where training once taught workers "how" to perform a task, education now helps workers discern "why" the task is being performed.
- Focus of performance measures and compensation shifts from activity to results.
- Advancement criteria change from performance to ability.

4. Reengineering Roles

Although a company might hire a BPR consultant to advise it on how to undertake a reengineering project, it is the organization's personnel who conduct the reengineering of business processes. This is because the employees of the organization know best what the company does, and how business could be better conducted. Personnel fill five key roles during a reengineering project: leader, member of the reengineering steering committee, reengineering czar, process owner, and member of the reengineering team

(Hammer and Champy, 1993). "In an ideal world, the relationship among these is as follows: The leader appoints the process owner, who convenes a reengineering team to reengineer the process, with the assistance from the czar and under the auspices of the steering committee" (Hammer and Champy, 1993).

The leader is an executive level manager who oversees the reengineering effort. He/she must have the clout required to persuade reluctant organizational members to embrace the change program. "That means reengineering must be led by people with the authority to oversee a process from end to end or top to bottom" (Stewart, 1993). The leader's role is to motivate and create a corporate vision while ensuring the program has continuing financial and managerial support. "A leader articulates a vision and persuades people that they want to become part of it, so that they willingly, even enthusiastically, accept the distress that accompanies its realization" (Hammer and Champy, 1993). He/she must create and maintain a sense of urgency for change. "Reengineering will break apart under political pressure or peter out after a few easy gains unless the case for doing it is compelling, urgent, and constantly refreshed" (Stewart, 1993). The leader is also responsible for appointing an owner to each process and approving reengineering team membership. (Hammer and Champy, 1993)

The steering committee is a group of senior managers who define the organization's reengineering strategy. Some of these managers may also be process owners or the reengineering czar. The reengineering leader is often the chairperson of this committee. The steering committee determines project priority, controls resource allocations and provide assistance to reengineering teams on problem resolution. (Hammer and Champy, 1993)

The reengineering czar is the organizational expert on reengineering procedures and tools. "The czar has two main functions: one, enabling and supporting each individual process owner and reengineering team; and, two, coordinating all ongoing reengineering activities" (Hammer and Champy, 1993). He/she is a technical advisor to team members and leadership officials, alike. This person must be able to oversee all

reengineering projects from start to finish. "The ideal reengineering czar, therefore, is not a department head, staff officer, or information officer but the CEO (Chief Executive Officer), COO (Chief Operations Officer), or her equivalent at the business-unit level" (Stewart, 1993).

The process owner is a senior leader who is responsible for the effective and efficient functioning of a particular business process. "Usually the process owner is someone who is already responsible for one or more of the organizations involved in the process" (Klein, M., 1993). He/she manages any change efforts that affect his/her process. The owner provides process information to the reengineering team during the change effort. Once a new design is completed the process owner becomes responsible for implementation of the changes and continued optimization of process performance. (Hammer and Champy, 1993)

The reengineering team performs the actual reengineering process. The team normally consists of five to ten employees. Included are people from various functional specialties, including a member who is well versed in the latest information technologies. Team members need not all be workers from the process under study. There should be members who are from outside the process because they may be more objective and open to possible process innovations.

The team members should be assigned to the reengineering effort on a full-time basis, if possible. Because process analysis and redesign is time consuming and must be completed in a limited amount of time, a minimum of 75% commitment level is required for project success. (Hammer and Champy, 1993)

C. BPR METHODOLOGIES

A plethora of magazine articles and books have been published in the past five years on the topic of process improvement. Although the authors of most of these writings state that a company should conduct BPR, very few discuss how to actually perform BPR. Even Hammer and Champy in their book entitled *Reengineering the*

Corporation, while providing great insight into BPR, do not provide a BPR methodology. Of those authors who give guidance on how to perform BPR, only a small percentage provide detailed steps. They enumerate generic stages and state only what tasks should be completed within each phase with no guidance on how to do them. Even fewer writings specify physical or technological tools to be used when performing the methodology.

Three published BPR methodologies are briefly discussed in the following sections as a sampling of existing BPR procedures. Each of these methodologies offers a slightly different slant to conducting BPR. There are similarities, however, in the overall flow of the sequential phases. First, a change sponsor, plan and team are assembled. Next, the existing business processes are documented. The processes are then analyzed for possible improvements. Any supporting technological or social changes are identified and put in place. Finally, the new process is implemented and monitored for future improvements. A comparison of the phases of each methodology is contained in Table 1.

The first of these methodologies is from a magazine article written by Mark Klein (Klein, M., 1993). It is one of the few articles found that includes information on how to conduct BPR. He, however, delineates only generic stages to follow when reengineering. The two succeeding methodologies are from books written by Thomas H. Davenport (Davenport, 1993) and H. J. Harrington (Harrington, 1991). Each of these authors provide detailed steps for accomplishing BPR.

1. Klein's Five Stages of BPR

Mark M. Klein, Senior Vice President and Managing Director of Management Consulting Services at Gateway, a consulting firm that specializes in BPR training, tools and support, delineates a five stage methodology for conducting BPR. These phases are Preparation, Identification, Vision, Technical and Social Solutions, and Transformation. (Klein, M., 1993) Klein's methodology is shown in Figure 2.

Klein	Davenport	Harrington
Preparation	Identify Processes for Innovation, and Identify Change Levers	Organize for Improvement
Identification	Understand Existing Processes	Understand the Process
Vision	Develop Process Visions	Streamline
Technical and Social Solutions	Design and Prototype	Streamline
Transformation	Design and Prototype	Measure and Control, and Continuous Improvement

Table 1. Comparison of BPR Methodology Phases

During the Preparation stage, reengineering teams are mobilized, organized and trained. Change plans are generated by the steering committee that promote the reengineering strategy of the company.

The Identification stage involves developing a customer-oriented process model of the business. Each business product is specified and a process map of the present state of the process is prepared. Activities contained within the process map are then analyzed to determine if they add value to the final business product.

Once present business processes have been identified and analyzed, a new process vision is developed that states where the business should be in terms of productivity and market share. Process improvements are then identified that meet the performance

PHASE I: PREPARATION

Step 1: Mobilize, Organize and Energize the People Who Will Perform Reengineering

Step 2: Prepare and Charter a Game Plan

PHASE II: IDENTIFICATION

Step 1: Develop and Understand a Customer-Oriented Process Model of the Business

Step 2: Identify Activities that Add Value

PHASE III: VISION

Step 1: Develop a Process Vision Capable of Achieving Breakthrough Performance

Step 2: Define What Changes are Required

Step 3: State the New Process Vision

PHASE IV: TECHNICAL AND SOCIAL SOLUTIONS

Step 1: Specify the Technical and Social Dimensions of the New Process

Step 2: Describe and Plan for the Technology, Standards and Procedure Needs as Well as Staffing, Recruitment, Education and Training Needs

PHASE V: TRANSFORMATION

Step 1: Realize the Process Vision

Step 2: Embark on a Pilot Program and Employ Continual Change Mechanisms

Figure 2. Klein's Five Stages of BPR, After Klein, M., 1993

requirements of the vision statement. Supporting changes to the organizational structure and task arrangement are also defined.

In the Technical and Social Solutions phase, the action team determines what technologies, standards and procedures will be required to support the improved process. Social changes to staffing, recruitment, rewards, and training are also specified. As Klein states:

> Applying technology without social reengineering is automation. Applying social change without technology is reorganization or quality. Only the joint design of the technical and social aspects of a process is BPR, and it is BPR that is most likely to produce breakthroughs in performance. (Klein, M., 1993)

In the Transformation phase, the new or improved processes are implemented. Change then becomes a continuous mechanism that is used to keep the reengineered processes current and efficient.

2. Davenport's High-Level Approach to Process Innovation

Thomas H. Davenport provides a framework for process innovation that consists of five phases: Identify Processes for Innovation, Identify Change Levers, Develop Process Visions, Understand Existing Processes, and Design and Prototype the New Process (Davenport, 1993). Figure 3 lists the phases and steps in Davenport's High-Level Approach to Process Innovation.

a. Phase I: Identify Processes for Innovation

In the first phase of Davenport's methodology, the key processes of an organization are identified and prioritized for analysis. In the first step of this phase, the major processes within the organization are enumerated. This is accomplished by broadly defining the purpose of the business into ten to twenty key processes. The boundaries of each process are then determined to stipulate where one process ends and another one begins. Process interdependencies are also identified.

Next, the strategic relevance of each process to the overall goals of the company is assessed. Each process is then examined and a judgment is made about the "health" of the process:

> Among the many symptoms of unhealthy processes is the existence of multiple buffers, reflected in work-in-process queuing up at each step...Process health is also suspect if a process crosses many functions and involves many narrowly defined jobs or has no clear owner or customers. Good indicators here are if no one gets upset when the process product is late or over budget, or no one is sure whom to call when deficiencies are noted. (Davenport, 1993)

PHASE I: IDENTIFY PROCESSES FOR INNOVATION

Step 1: Enumerate Major Processes
Step 2: Determine Process Boundaries
Step 3: Assess Strategic Relevance of Each Process
Step 4: Render High-Level Judgments of the "Health" of Each Process
Step 5: Qualify the Culture and Politics of Each Process

PHASE II: IDENTIFY CHANGE LEVERS

Step 1: Identify Potential Technological and Human Opportunities for Process Change
Step 2: Identify Potentially Constraining Technological and Human Factors
Step 3: Research Opportunities in Terms of Application to Specific Processes
Step 4: Determine Which Constraints will be Accepted

PHASE III: DEVELOP PROCESS VISIONS

Step 1: Assess Existing Business Strategy for Process Directions
Step 2: Consult with Process Customers for Performance Objectives
Step 3: Benchmark for Process Performance Targets and Examples of Innovation
Step 4: Formulate Process Performance Objectives
Step 5: Develop Specific Process Attributes

PHASE IV: UNDERSTAND EXISTING PROCESSES

Step 1: Describe the Current Process Flow
Step 2: Measure the Process in Terms of the New Process Objectives
Step 3: Assess the Process in Terms of New Process Attributes
Step 4: Identify Problems with or Shortcomings of the Process
Step 5: Identify Short-Term Improvements in the Process
Step 6: Assess Current Information Technology and Organization

PHASE V: DESIGN AND PROTOTYPE THE NEW PROCESS

Step 1: Brainstorm Design Alternatives
Step 2: Assess Feasibility, Risk, and Benefit of Design Alternatives and Select the Preferred Process Design
Step 3: Prototype the New Process Design
Step 4: Develop a Migration Strategy
Step 5: Implement New Organizational Structures and Systems

Figure 3. Davenport's High-Level Approach to Process Innovation, Davenport, 1993

Next, the corporate culture and political pressures associated with each process are evaluated. "The primary goal of process qualification is to gauge the cultural and political climate of a target process...(and)...to select only processes that have a committed sponsor and exhibit a pressing business need for improvement" (Davenport, 1993).

Finally, in phase one, processes are prioritized for reengineering based upon the marks given to each on the factors of strategic relevance, process health and level of sponsorship. The process that is most closely tied to the strategy of the corporation, that is most problematic and that has the political sponsorship required for change is first in line for improvement. The other processes will be reengineered when time and resources permit.

b. Phase II: Identify Change Levers

During the second phase of Davenport's methodology, available change levers are identified. The first step of this phase involves looking at the process and determining what potential technological and human factors exist that can help to improve it. Possible areas wherein technology may assist in process improvement were previously listed on page 14. Next, human factors that can assist in the reengineering effort are identified. Human focused change levers include the reorganization of functional work units into process oriented teams, the involvement of employees in the change, and corporate-wide education on reengineering principles and the need for process improvement.

After opportunities for change are identified, any technological and human factors that might constrain process improvements are examined. Technological limitations include existing legacy computer systems:

> Existing systems are often too expensive, complex, and embedded in an organization to simply assume them away. Instead of pretending to have a clean slate, firms should acknowledge the constraints existing

> systems impose on a new process, understand their implications, and make the best of them. (Davenport, 1993)

Human limitations to process improvement include structural and cultural constraints. "Structural and cultural constraints to process innovation include strict hierarchical structures, cultures unreceptive to innovation, and general organizational rigidity or inability to accommodate change" (Davenport, 1993).

Once change levers and obstacles have been identified, their affects on the process being considered for reengineering are ascertained. There is then a determination made as to which change levers will be utilized to improve the process and which constraints will be accepted or challenged.

c. *Phase III: Develop Process Visions*

In the third phase of the methodology, a process vision is created that provides measurable process objectives and characteristics. The company's existing business strategy is first assessed to determine the direction that the business owner desires to take in the future development of the company. This strategy will define the objectives of the process improvement initiative. "A well-defined strategy, in particular, is essential to provide both a context for process innovation and the motivation to undertake it" (Davenport, 1993).

Next, process customers are consulted and their needs and product desires are determined. "The type of inputs that should be solicited from customers are broad, encompassing desired process outputs, performance, flow, enablers, and other relevant factors" (Davenport, 1993). This information is used to further refine the performance objectives of the process.

The process is then benchmarked against those of similar companies. The goal of examining the work of other companies in the industry is to find examples of possible process innovations and to refine performance requirements for the business. "Benchmarking can identify realistic performance objectives and target characteristics for

companies to match or surpass, information that can be used during innovation brainstorming workshops to fuel the redesign process" (Davenport, 1993).

With the information gathered from the business' strategy, customers and competitors in the industry, new performance objectives are formulated for the process being reengineered. "Process objectives include the overall process goal, specific type of improvement desired, and numeric target for the innovation, as well as the time frame in which the objectives are to be accomplished" (Davenport, 1993). Specific process attributes are then developed to describe how these objectives will be achieved.

d. Phase IV: Understand Existing Processes

During the fourth phase of the innovation procedure, the current state of the process and its workflow are described. Because the existing process will be used as a baseline for measuring the success of proposed improvements, the present process is assessed in terms of the performance objectives and attributes of the target process. The inefficiencies of the process are then identified and short-term fixes for these problems are specified. The analysis of the present process includes an evaluation of the process' supporting information infrastructure and organizational knowledge, skills and employee base.

e. Phase V: Design and Prototype the New Process

The final phase of Davenport's methodology involves the design and prototype of the new process. The change team first brainstorms several new process design alternatives. Each alternative is then assessed for feasibility, risk and benefit to the organization. The best process alternative is selected for implementation. Next, a prototype of the new process is developed and deployed to test the process design and shape the supporting information systems.

Once a final process design is achieved, a migration strategy from the old to the new process is developed. Finally, the new system and its supporting organizational structures are implemented.

3. Harrington's Five Phases of Business Process Improvement

H. J. Harrington, an International Quality Advisor from Ernst & Young, provides a five-phased approach to conducting process improvement. These stages are Organizing for Improvement, Understanding the Process, Streamlining, Measurements and Controls, and Continuous Improvement. (Harrington, 1991) The phases of Business Process Improvement (BPI) and their encompassed steps are listed in Figure 4.

a. Phase I: Organizing for Improvement

During the initial phase of Harrington's methodology, a commitment to process improvement is made, an understanding of reengineering principles is built and project leadership is identified. During the first step of this phase, an executive improvement team is established which functions as the reengineering steering committee. This group is tasked to write process improvement procedures and vision statements, authorize process improvement proposals, and approve job descriptions for process owners and reengineering team members.

Next, a champion of change is identified and appointed by the steering committee to be the reengineering czar. This person is responsible for developing and overseeing process improvement efforts within the organization. "He or she should have high standards, believe the company can be better, embrace change, be a good salesperson, know how to lead teams, and want to take a leadership role in an activity that will have a long-term impact on the firm's business processes" (Harrington, 1991).

The executive improvement team is then trained on the practice of process decomposition, and on reengineering concepts, principles, and tools. They then develop a corporation model for conducting reengineering. This model represents the methodology, tools and resources to be used during the reengineering effort. Any written methodology obtained from literature or from consulting firms is tailored to the organization's culture, personnel capabilities and operating environment by the steering committee.

PHASE I: ORGANIZING FOR IMPROVEMENT
- Step 1: Establish a Executive Improvement Team
- Step 2: Appoint a Business Process Improvement Champion
- Step 3: Provide Executive Training
- Step 4: Develop an Improvement Model
- Step 5: Communicate Goals to Employees
- Step 6: Review Business Strategy and Customer Requirements
- Step 7: Select the Critical Processes
- Step 8: Appoint Process Owners
- Step 9: Select the Process Improvement Team

PHASE II: UNDERSTANDING THE PROCESS
- Step 1: Define the Process Scope and Mission
- Step 2: Define Process Boundaries
- Step 3: Provide Team Training
- Step 4: Develop a Process Overview
- Step 5: Define Customer and Business Measurements and Expectations
- Step 6: Flow Diagram the Process
- Step 7: Collect Cost, Time, and Value Data
- Step 8: Perform Process Walkthroughs
- Step 9: Resolve Differences
- Step 10: Update Process Documentation

PHASE III: STREAMLINING
- Step 1: Provide Team Training
- Step 2: Identify Improvement Opportunities
- Step 3: Eliminate Bureaucracy
- Step 4: Eliminate No-Value-Added Activities
- Step 5: Simplify the Process
- Step 6: Reduce Process Time
- Step 7: Errorproof the Process
- Step 8: Upgrade Equipment
- Step 9: Standardize
- Step 10: Automate
- Step 11: Document the Process
- Step 12: Select the Employees
- Step 13: Train the Employees

PHASE IV: MEASUREMENT AND CONTROL
- Step 1: Develop In-Process Measurements and Targets
- Step 2: Establish a Feedback System
- Step 3: Audit the Process Periodically
- Step 4: Establish a Poor-Quality Cost System

PHASE V: CONTINUOUS IMPROVEMENT
- Step 1: Qualify the Process
- Step 2: Perform Periodic Qualification Reviews
- Step 3: Define and Eliminate Process Problems
- Step 4: Evaluate the Change Impact on Business and Customers
- Step 5: Benchmark the Process
- Step 6: Provide Advanced Team Training

Figure 4. The Five Phases of BPI, After Harrington, 1991

Once the improvement model is formulated, it is published and communicated to the organization's employees as part of a process improvement directive. This directive communicates the purpose and principles of reengineering, the need for process improvement, and the BPR approach to be taken during improvement projects. The directive also delineates the responsibilities of each corporate employee during a reengineering effort.

The executive team then identifies the organization's critical business processes. "In short, it (the executive improvement team) should answer the questions, 'What do we do as a business?' and 'How do we do it?'" (Harrington, 1991). They do this after reviewing the business' operating strategy and the needs of its customers.

Once the business' processes are identified, they are prioritized, process owners are assigned to each and processes are selected for improvement. "The processes that are selected should be ones where management and/or customers are not happy with the status quo" (Harrington, 1991). Selection criteria include the impact of the process on the customer, the ability of the organization to change the process, the performance status of the process, the impact of the process on the success of the business and the availability of resources required to effect the proposed changes.

Finally, in the first phase of Harrington's methodology, a process improvement team is selected and assigned. The members are appointed from departments involved in the process under review. Each representative is granted the authority by their department head to make decisions on the department's behalf.

b. Phase II: Understanding the Process

The objective of phase two of Harrington's methodology is for the reengineering team to examine, comprehend and document the present state of the process to be reengineered. The scope and mission of the process under review are first identified. The boundaries of the process are then defined, clearly depicting where the process begins

and ends. "The selection of these boundaries determines who will be involved in the process and what goes on within it" (Harrington, 1991).

Next, the process improvement team is educated on team dynamics, process improvement principles and problem-solving techniques. They are also trained on the tools to be used in the process improvement project. These tools include the following (Harrington, 1991):

- Process improvement concepts
- Process modeling
- Interviewing skills
- Performance measurement methods
- Cost and cycle time analysis
- Benchmarking
- Value analysis

The process to be reengineered is then analyzed and its high-level steps are determined. Process customers, both internal and external to the company, are identified, as are the process' overall inputs and outputs. All of these aspects of the process are then documented by the process improvement team by means of a block diagram.

Next, the customers of the process are interviewed to determine their needs and their expectations about the quality, productivity and adaptability of the company's product or service. These requirements are translated into performance targets and measurement criteria for the process. Effective measures are extremely important to process improvement:

> Measurements are the starting point for improvements because they enable you to understand what the goals are. Without them, needed change and improvement in the process are severely hindered. (Harrington, 1991)

In the next step, the process is broken down into its component subprocesses and tasks. The inputs, outputs and flow of each task are also identified. The process is then diagrammed using flowcharting techniques. "Flowcharting is defined as a method of graphically describing an existing process or a proposed new process by using simple symbols, lines, and words to display pictorially the activities and sequence in the process" (Harrington, 1991). Flow diagrams make a process easier for team members to understand, disciplines their way of thinking, and documents the process for future analysis.

Once the process has been diagrammed, additional process data is collected and recorded. The improvement team gathers data on the cost of each step in terms of the amount of resources consumed, the value that the task adds to the output of the process, and the process' cycle time. Cycle time is the total time required to complete the process. "It includes not only the time taken to perform the work abut also the time spent moving documents, waiting, storing, reviewing, and reworking" (Harrington, 1991).

Finally, process walkthroughs are performed by the improvement team. The goal of a walkthrough is to ensure that the diagrammed process matches the actual process. Seeing how the process is actually performed results in a greater understanding of the process and its strengths and weaknesses. Any differences between the model and the actual process are resolved, and the process model is updated.

c. Phase III: Streamlining

The Streamlining phase of BPI involves identifying ways of improving the efficiency, effectiveness and flexibility of the business process. The improvement team is first trained on methods that can be used to improve business procedures. The documented processes are then analyzed and opportunities for redesign are identified.

The first streamlining technique is to eliminate any unnecessary bureaucracy from the process. Bureaucracy is the unneeded administrative paperwork,

controls or approvals that exist within the process. These administrative tasks slow down the cycle time of the operation and do not add value to the final product.

Each of the activities that comprise a process is evaluated to determine if it adds value to the overall process. "Real-value-added (RVA) activities are those activities that, when viewed by the end customer, are required to provide the output that the customer is expecting" (Harrington, 1991). If an activity is not required to produce the company's product or service, and does not contribute to the satisfaction of customer's requirements or an internal business function, it is eliminated.

The improvement team then tries to simplify the process. Complex tasks are made less complicated and easier to manage. Similar activities are combined, duplicated tasks are eliminated, the number and length of meetings are reduced, correspondence and reports are standardized, and the number of hand-offs between employees is decreased.

Next, process completion time is reduced. "Reducing total cycle time frees resources, reduces cost, improves the quality of the output, and can increase sales" (Harrington, 1991). Cycle time is decreased by completing tasks in parallel instead of in serial order, reducing work interruptions, and setting task priorities.

The process is then errorproofed to decrease the amount of rework required and to minimize the wasting of resources. This is done by establishing standardized operating procedures, using automated error checking tools, and rewarding accuracy in work performance.

The process is also streamlined by upgrading the capital equipment that is used to perform the work. Office equipment such as duplicating machines, telephones and computer systems is installed or enhanced. The office environment is also improved by adjusting workspace lighting and temperature, and controlling noise levels.

Tasks can likewise be streamlined through standardization. "Standardization of work procedures is important to ensure that all current and future employees use the best ways to perform activities related to the process" (Harrington,

1991). Clear and concise operating procedures are established for each activity that delineate the required method of task performance.

Tasks that can be improved by automation are automated. Equipment and information systems are installed to perform tedious and routine activities. Workers are then free to perform more creative and fulfilling tasks.

When streamlining efforts are complete, the new process is documented on an updated flowchart. Employees are then selected to participate in the new process and are trained on the new operating procedures. Positions that are no longer required are abolished.

d. Phase IV: Measurement and Control

The goal of the fourth phase of Harrington's methodology is to implement a system of process controls that will help to ensure that the implemented process is continuously considered for improvement. In-process measurements and targets are established to provide immediate and accurate feedback on the process' status:

> As important as measurement is, by itself it is worthless. Unless an effective feedback system exists, measurement is a waste of time, effort, and money. Specific feedback enables an individual to react to the data and correct any problems. (Harrington, 1991)

Each activity is measured against the previously defined performance objectives. Immediate performance information is then provided to the employee carrying out the work and is available to the process owner.

Periodical audits are conducted to ensure the process is functioning effectively and efficiently. These inspections are conducted by an independent third party who has no direct interest in the outcome of the investigation. A poor-quality cost system is also established to quantify the amount of company money spent to fix low quality goods or services.

e. Phase V: Continuous Improvement

The final phase of BPI entails the implementation of a continuous process improvement program. Continuous improvement is important to keep the process functioning at the highest possible level. Modifications to the process may be required over time in response to changes in the business' operating environment, the availability of new equipment and procedures, changes in the needs and expectations of customers, and changes in employee knowledge and skills.

During this phase, the process' status is qualified:

> Qualification involves evaluating a complete process, consisting of many individually certified activities, to determine whether the process can perform at the appropriate level when the activities are linked together. In addition, the process must demonstrate that it can repeatedly produce products and/or services on time, at the appropriate cost, that meet customer expectations on an ongoing basis. (Harrington, 1991)

The process is ranked on a six-level quality scale. The six levels of process qualification are described in Figure 5. This incremental improvement procedure is used when resources are limited and the costs to take a process directly to Level 1 are prohibitive. The process' level is recorded and future improvement projects are planned to get the process to a Level 1 grade.

Periodic reviews are performed on the process to evaluate its performance. An examination of the process' rating against its performance measures is conducted and the process is, again, benchmarked against the best practices in industry. The impacts of the process improvements on the business and its customers are also assessed. This data is used to verify the accuracy of the process' qualification level. A determination is then made about whether or not the company is ready to take the necessary steps to move the process to the next qualification level, beginning the process improvement cycle anew.

Level	Status	Description
6	Unknown	Process status has not been determined.
5	Understood	Process design is understood and operates according to prescribed documentation.
4	Effective	Process is systematically measured, streamlining has started, and end-customer expectations are met.
3	Efficient	Process is streamlined and is more efficient.
2	Error-Free	Process is highly effective (error-free) and efficient.
1	World-Class	Process is world-class and continues to improve.

Figure 5. Six Levels of Process Qualification, After Harrington, 1991, p. 206

D. EVALUATION OF BPR METHODOLOGIES

It has been estimated that 50-70 percent of business process reengineering projects fail to meet their objectives. There are many reasons for this poor performance such as a lack of top management support and\or adequate project resources, the failure of the change team to consider the overall process, and not implementing identified process changes (Hammer and Champy, 1993). The lack of a detailed methodology that specifies tools to be used in a reengineering effort is yet another reason for BPR failures:

> Unfortunately, it is generally acknowledged that the practice of reengineering is still more art than science, and results are often unpredictable. Although some principles and guidelines have been proposed, a systematic framework or methodology has yet to be developed. (Yu and Mylopoulos, 1994)

Klein also states that "...much confusion arises from the fact that most writing about BPR (including this article) tells you *what it is*, but not *how to do it*" (Klein, M., 1993).

The Department of Defense (DoD), in its manual on business process reengineering, states that an effective methodology for change must be (DODINST 8020.1-M, 1993):

- **Complete:** It must provide steps that directs a business process improvement procedure from establishment to implementation.
- **Applicable:** The methodology must be able to be used on any process of the business.
- **Friendly:** The procedure must be easy for all personnel, including non-technical workers and managers, to learn and understand.
- **Consistent:** It must be the only method used to conduct reengineering within the organization. This will allow in-house reengineering expertise to be developed.
- **Supported:** The reengineering procedure must include detailed documentation, training courses and project management tools.
- **Successful:** The methodology should have a record of success and these cases should be available to guide the actions of the reengineering team.
- **Documenting:** The procedure must produce process documentation as it is used.
- **Enabled by Tools:** The method must be supported by automated tools that help to ease the reengineering workload and enable process documentation and measurement.

Each of the three published methodologies detailed in the previous section have weaknesses when compared to these characteristics. This determination is based upon a thorough examination of the materials provided only in the authors' published writings. It is not based on any other information provided by the authors.

Klein's methodology is commendable because he uses easy to understand terminology for its phases and steps, and he considers the often overlooked area of the

social impact of reengineering. He stresses the need to provide education and training for the business' employees.

However, as described in this particular article, Klein's methodology is not complete. He does not provide enough detail in the steps of his methodology, and he does not prescribe how to complete each task. For example, step one of the Transformation phase, Realize the Process Vision, is a very broad statement that might possibly include installing the technical and social solutions delineated in the previous stage of the methodology. Klein makes no mention of the need to gain top management's support for the reengineering project or of analyzing the project environment. He does not delineate the process data that must be captured to complete the process model and gives no concrete guidance on how to improve the business process. Also, there is no reference about using simulation tools to test the new process prior to implementation.

Based upon the information Klein furnishes, it does appear that his procedure would be applicable to any process and would prove to be a consistent method for reengineering projects. However, Klein provides no supporting information for, or process documentation during, his methodology. Furthermore, he does not specify any tools, automated or not, to be used in the reengineering effort, or any examples of the methodology's successful use.

Davenport provides more detailed steps to be followed when conducting reengineering. He gives in-depth guidance on how to analyze the project environment to identify change levers and obstacles. He also specifies, in great detail, how to select a process for innovation and provides some information on gathering performance objectives for the process under consideration. His method appears applicable to most any process and would provide a consistent BPR procedure.

Davenport's methodology, however, is not comprehensive. Davenport fails to specify steps for gaining management sponsorship or establishing key leadership roles in the reengineering effort. He appears to focus most of his attention on how to gather information on what the process should do, and on how to identify obstacles to change.

He does not provide, however, enough detailed direction on how to actually improve the business process. Because his procedure lacks direction on how to identify changes to a process, there is also no provision of supporting documentation or training devices. Although Davenport delineates several areas wherein information technology can assist in the reengineering effort, he does not specify any automated tools to be used for completing each step of his methodology.

Harrington's methodology is the most complete of the three methodologies evaluated. Harrington furnishes detailed steps to complete when performing BPR. He provides guidance on how to organize for improvement and emphasizes additional team and employee training throughout the procedure. He specifies what data should be collected prior to analyzing a process and provides some guidance on how to make process improvements. His methods seem easy to use, appear consistent, are well supported with educational material, and produce process documentation as they are used. Harrington also provides examples of the successful use of his methods and specifies tools that can be used during each step.

Harrington does not, however, specify computerized software tools to be used during the BPR effort. He also does not mention the use of simulation tools prior to process implementation.

The next chapter describes a methodology that DoD uses for process improvement program. This methodology includes detailed steps and provides specific supporting software tools for each activity.

III. DEPARTMENT OF DEFENSE BPR METHODOLOGY

This chapter provides an overview of the reengineering methodology used by the Department of Defense. It begins by discussing the background of the department's process improvement program. It then delineates the goals of the Functional Process Improvement Program. Finally, it describes and evaluates the methodology and tools used in the reengineering effort.

A. BACKGROUND

During the industrial age, the United States government followed the paradigm of industry and built centralized, hierarchical bureaucracies by which to conduct the public's business. Each layer of bureaucracy performed simple tasks and operated by specific rules and regulations. An emphasis on procedures, and ensuring procedures were being enforced, stole resources away from services that could have been provided to taxpayers. As a result of the rigid internal controls, the process of requesting and receiving services was cumbersome and slow. These legacy bureaucracies, although obsolete, survived on into the information age. (Gore, 1993)

1. National Performance Review

The National Performance Review (NPR) was an intensive six month study of the federal government by the federal government. The NPR began on March 3, 1993, when President Clinton tasked Vice President Gore with leading an effort to streamline federal business processes. The goals of the examination were to move "...from red tape to results to create a government that works better and costs less" (Gore, 1993). All cabinet members were asked to create reinvention teams and laboratories within their departments to assist in the reengineering of government. The focus of the NPR was on not what government should do, but how it should work to provide improved service to its customers, the American public. (Gore, 1993)

The NPR report of September 1993 encompassed four key principles. The first was to cut red tape by transforming systems that are rule based to ones that are results based. The second principle was to put the customer first by restructuring the focus of government operations to meet the customer's needs. A third tenet was to empower federal employees by transforming the organizational culture and structure of the public sector to decentralize authority and allow the employees to get results. Finally, the NPR would bring government agencies back to basics by:

> ...reengineering how they do their work and reexamining programs and processes. They abandon the obsolete, eliminate duplication, and...embrace advanced technologies to cut costs. (Gore, 1993)

The NPR report recommendations included process improvements that would result in an overall savings of $108 billion over five years. Of that amount, $5.4 billion would be saved through the use of information technology to consolidate and modernize the government's information infrastructure. Another $40.4 billion would be saved by streamlining the bureaucracy through the reengineering of work processes. Because many of these innovations require supporting legislative action to ordain, the proposed transformation may take six to ten years at best to complete. (Gore, 1993)

In December of 1994, the President initiated Phase II of the NPR that builds upon the efforts of the initial study. Its goals are to eliminate or privatize programs, devolve federal authority to state or local governments, and reinvent the regulatory systems of government agencies. Both phases of the NPR are targeted to be complete by the summer of 1996. (*National Performance Review Phase II Background Paper*, 1994)

2. Corporate Information Management

The Department of Defense (DoD) is being downsized in direct response to a decreased Communist threat and the decline of available budgetary resources. Smaller force strengths and new, unpredictable, missions in diverse global locations mandate the

adoption of more effective and efficient operations. The Secretary of Defense (SECDEF), as part of the overall NPR initiative, challenged DoD to "...establish programs that will reduce cycle times by at least 50 percent by the year 2000 through process reengineering and technological breakthroughs" (Dalton, 1994).

In response, DoD launched the Corporate Information Management (CIM) program. The initiative requires the examination and viable restructuring of all business processes throughout the department. The premise of the program is that DoD can readily maintain its mission capability by implementing improved processes which: (1) are enabled by technology; (2) substantially increase productivity; (3) decrease costs; and (4) do not sacrifice quality. The principles of CIM direct activity managers to (*A Plan for Corporate Information Management....*, 1993):

- Weigh each systems management action against broad DoD objectives.
- Develop and enhance information systems in the context of process models.
- Routinely subject existing and proposed business methods to cost-benefit analysis and benchmark them against leading public and private sector practices.
- Simplify processes by elimination and integration instead of automation.
- Define and incorporate measures of performance into each process.
- Prove and validate new business methods before implementation via simulation and prototypes.
- Provide consistent and friendly interfaces with the user.
- Control and restrict employee access to information systems and the data contained therein.
- Make the computing and communications infrastructure transparent to the information systems that it supports.
- Enter data into a system only once to reduce errors and cost, and improve currency.

B. FUNCTIONAL PROCESS IMPROVEMENT PROGRAM

In January 1992, the CIM Information Technology Policy Board established the Functional Process Improvement (FPI) program, DoD's version of BPR. The program has five key objectives. First, DoD will reduce its cost of doing business by eliminating the unnecessary waste of resources through the reevaluation and restructuring of unproductive procedures and regulations. Second, organizations will identify and quantify the cost of its products and services, and use the principles of CIM to improve productivity, quality and customer service. As a result of the implementation of unit cost management, activities will begin fee-for-service operations under the Defense Business Operations Fund (DBOF) wherein they will be required to institute competitive business practices to maintain their livelihoods. The fourth objective is to create an environment in which DoD activities maintain continuous process improvement to permit quick and easy response to changes in mission, resources, and customer demands. Finally, the FPI will empower command leaders to improve their business practices and will make them directly accountable for the success or failure of their organizations. (DODINST 8020.1-M, 1993)

C. FPI METHODOLOGY AND TOOLS

To assist DoD managers achieving these goals, the Defense Information Systems Agency (DISA) established the Center for Functional Process Improvement Expertise. This center provides process reengineering tools and procedural guidance to defense activities. To support these efforts, DISA distributes several FPI publications. One such volume is the Functional Process Improvement manual that delineates a step-by-step BPR methodology for DoD activities to follow when implementing process reengineering programs. (DODINST 8020.1-M, 1993)

There are six phases and 14 steps in the FPI methodology, which are listed in Figure 6. The manager first defines a function's (process's) present environment, and then specifies objectives for the new process and strategies for their achievement. Processes

PHASE 1: DEFINE

Step 1: Establish the Functional Architecture
Step 2: Delineate the Strategic Plan
Step 3: Ascertain the Process Baselines
Step 4: Define the Information System Baseline

PHASE 2: ANALYZE

Step 5: Perform Activity Modeling
Step 6: Perform Data Modeling

PHASE 3: EVALUATE

Step 7: Identify, Evaluate and Select Possible Improvements

PHASE 4: PLAN

Step 8: Generate a Data Management Plan
Step 9: Produce a Technical Management Plan

PHASE 5: APPROVE

Step 10: Prepare the Functional Economic Analysis

PHASE 6: EXECUTE

Step 11: Execute Changes
Step 12: Develop Information Systems
Step 13: Revise Baseline
Step 14: Improve Program Oversight

Figure 6. Functional Process Improvement Methodology, After DODINST 8020.1-M, 1993

are analyzed and broken down into activities, and alternative procedures are defined. Each alternative is evaluated using tools such as activity and data modeling, economic analysis and simulation. The alternatives are narrowed down and detailed change plans are submitted for approval. Once sanctioned and implemented, the new process becomes the baseline function from which the cycle of improvement begins anew. Figure 7 reveals the recurring nature of the FPI methodology. A brief discussion of each phase and step in the FPI methodology cycle follows. (DODINST 8020.1-M, 1993)

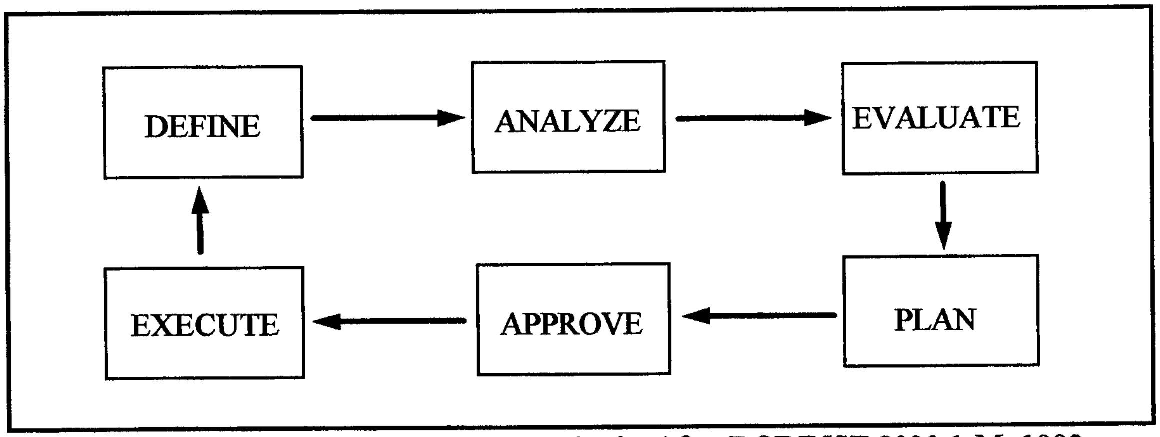

Figure 7. Functional Process Improvement Cycle, After DODINST 8020.1-M, 1993

1. Phase 1: Define

During the first phase of the FPI methodology, the desired outcomes of the process improvement initiative are determined. The strategy by which these goals will be achieved is also specified. Present processes and their supporting systems are identified and documented in an activity diagram. (DODINST 8020.1-M, 1993)

In step one, Establish the Functional Architecture, a description of the overall objectives of a particular functional (business) area is determined. This description is performed at a high level of abstraction, leaving the details about the process to be defined in a later step. The scope of the functional area is first defined and the boundaries of the area clearly delimited. This is accomplished after careful examination of the activity's prescribed mission statement, assigned responsibilities, and the command's location within the broader objectives of the DoD Enterprise Model.

The DoD Enterprise Model depicts the overall functional structure of the Defense Department and the relationships among DoD functions and their supporting systems. It is a fluid model, maintained at the department's headquarters, that is updated as process improvements are adopted. Within the model, the functions (processes) of DoD are broken down hierarchically into the areas shown in Figure 8.

The department has seven major mission areas: Business Operations; Information Management Infrastructure; Command and Control; Intelligence; Planning, Programming

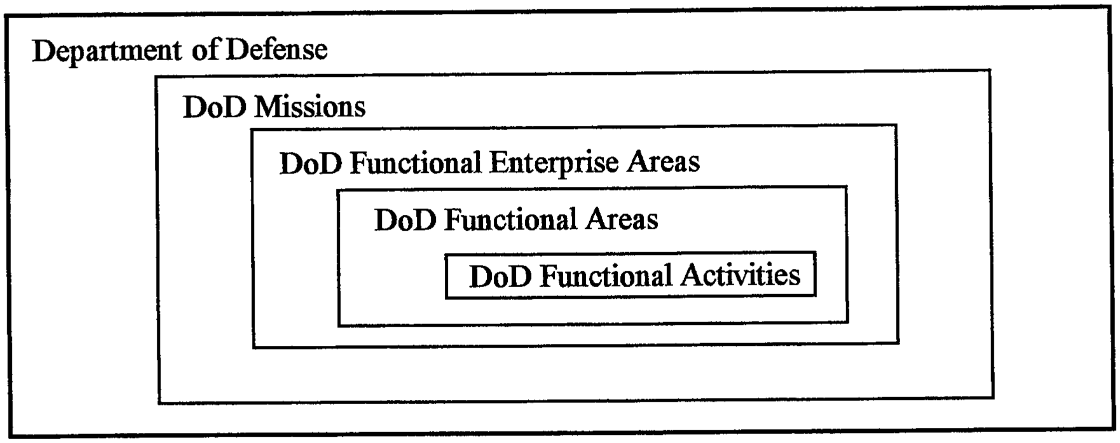

Figure 8. Hierarchical Structure for Department of Defense (DoD) Functions

and Budgeting System (PPBS), and Support Services; National Security Doctrine and Policy; and Joint Warfighting Plans. Each mission area is made up of at least one functional enterprise area that is a program area headed by an Assistant Secretary of Defense (ASD) or equivalent. Each enterprise area includes one or more functional areas. Figure 9 lists each DoD mission and a sample of the corresponding functional enterprise areas and functional areas.

After the goals have been specified for the business area, the functional activities that comprise the functional area are identified and defined. A functional activity is equivalent to a process in an activity model. A Functional Activity Program Manager is designated for each activity. This person is the process owner who will lead the improvement initiative within his/her assigned activity.

The first task for the Program Manager is to establish an interdisciplinary change team composed of both functional and technical experts. Using activity modeling, the team identifies and documents the overall structure of the functional area and its high level activities onto a context level activity diagram. The Integrated DEFinition Language (IDEF) is the standard modeling tool prescribed by DoD, and is the format in which the DoD Enterprise Model is maintained. Program Managers may use other tools, provided they can prove that its capability equals or surpasses that of IDEF.

Mission	Functional Enterprise Area	Responsible Entity	Functional Area
Business Operations	Fiscal Resources	DoD Comptroller	Civilian Pay Military Pay
	Human Resources, Personnel Support	ASD Force Mgt. & Personnel	Manpower Training
Information Management	Information Mgt.	ASD C3I*	Information Services
	Communications	ASD C3I	Information Networks
Command and Control	Command and Control	ASD C3I	Theater Command and Control
Intelligence	Intelligence	ASD C3I	Security
PPBS and Support Services	PPBS	DoD Comptroller	Budget Formulation
	External Liaison	ASD Public Affairs	Public Communications
National Security	National Security	USD Policy**	National Security
Joint Warfighting	Planning	Chairman, JCS***	Operational Planning

* C3I = Command, Control, Communications and Intelligence
** USD = Under Secretary of Defense
*** JCS = Joint Chiefs of Staff

Figure 9. DoD Mission and Component Areas, After DODINST 8020.1-M, 1993

An IDEF0 activity model is built using ICOMs. ICOM is the acronym for the four roles that an item may take in relation to an activity: input, control, output or mechanism. The input is the material and information resources used by an activity to produce output. Controls are rules and resource constraints that regulate the process. A mechanism is the person, machine or system that performs the activity. Figure 10 contains the legend for an IDEF0 activity model. Additional information on IDEF modeling can be found in IDEF0/SADT by David A. Marca and Clement L. McGowan. (*Functional Economic Analysis Guidebook*, 1993)

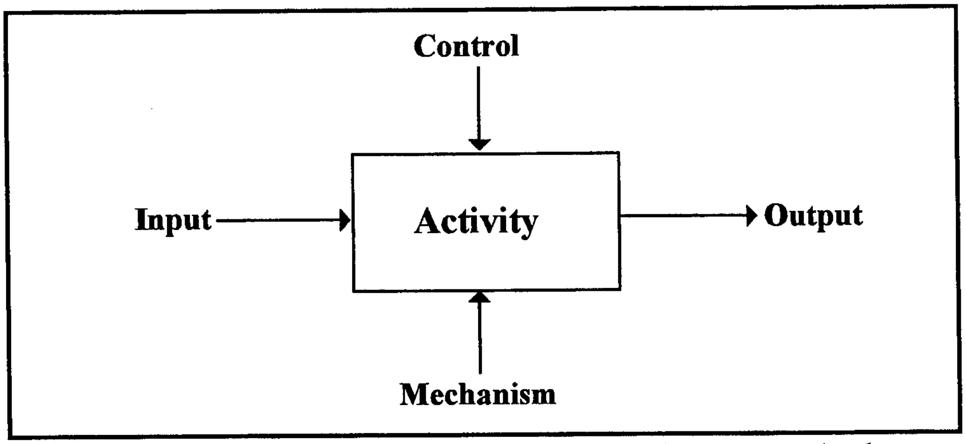

Figure 10. IDEF0 Model Legend, After *Functional Economic Analysis Guidebook*, 1993

In step two, Delineate the Strategic Plan, the change team outlines the management approach that will be used to identify, evaluate and select process improvement alternatives across the functional area in the next ten years. A plan is also made for each functional activity that includes actions to be taken within twelve to 18 months of project initiation. The activity plan specifies which processes and systems are under review, the tools and methods to be used in the improvement initiative, and performance measures by which the successful completion of the activity will be determined. "Performance measures can be dollars, actual or elapsed time, quality measures, and reaction/response capability" (DODINST 8020.1-M, 1993).

In the third step, Ascertain the Process Baseline, the present state of each functional activity is identified. If a previous process improvement initiative was undertaken, the models and figures from its documentation are used as input to this step. If no previous projects were undertaken, an initial baseline assessment is conducted wherein the change team determines how and why each task is conducted. The present cost of each activity is recorded. These costs include the expense of the supporting labor, information technology, facilities and materials.

Step four is Define the Information System Baseline. During this step, existing (legacy) information systems are analyzed and evaluated for effectiveness. Alterations or

additions to existing information systems are identified and a migration strategy to any required technology is determined.

2. Phase 2: Analyze

In step five, Perform Activity Modeling, activities are studied in greater detail. Each activity is broken down into functional processes, which are further broken into tasks. The inputs, outputs, controls, and mechanisms through which an activity is conducted are drawn as IDEF0 process models that are illustrated down to the task level. The result is an "as is" depiction of the functional activity and its required information. Figure 11 is a page of a completed activity model diagram.

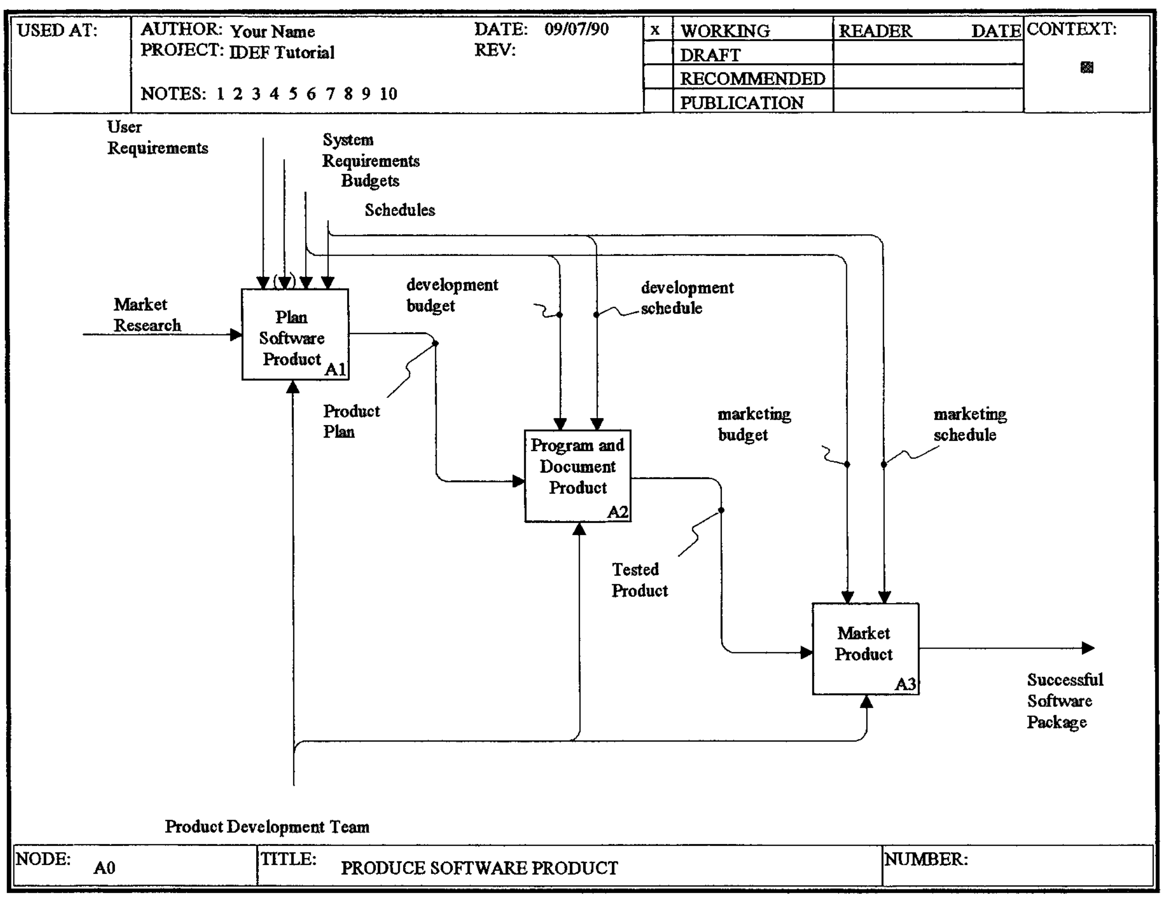

Figure 11. IDEF0 Activity Model, From *Design/IDEF 2.0*, 1993

After the activity model is completed, a financial baseline is calculated to determine the present cost of performing each task. Using current program funding amounts gathered in step three and an estimated workload, a cost analysis is performed using a procedure called Activity Based Costing:

> Activity based costing is a tool used to convert financial accounting costs to the costs of managing and performing the tasks that make up an activity model, as well as the costs of producing the outputs from those tasks. Activity based costing is valuable because it relates resources to tasks and products, not merely to organizations and time periods. (DODINST 8020.1-M, 1993)

An Activity Cost Worksheet is used to record the historic cost of an activity. An example worksheet is shown in Figure 12. Column one contains a listing of activities. Depending on the amount of detail to which a team wishes to study a functional activity, the worksheet can be completed at the task level and cost amounts then compiled to the activity level. Columns two through seven contain the standard cost drivers for DoD activities: civilian and military labor, information technology (info. tech.), facilities, material and other costs. Each activity or task listed in column one is assigned a value in each of the cost driver columns. These costs are totaled by activity and recorded in column eight, activity cost. Using the output performance measures specified in step two and the time period for which the costs have been gathered, an estimate of activity's output volume is made and recorded in column nine, activity output. The activity cost is then divided by the activity output to determine the unit cost. This amount is included in column ten. Column eleven, Operations (Opns.) contains an estimate of the percentage of activity cost that is spent on the primary output of the activity. It is used to calculate the amount of time and cost spent on non-operational functions. (*Functional Economic Analysis Guidebook*, 1993)

During step six, Perform Data Modeling, the data required as input to each process is specified and captured in an IDEFX data model. A data model shows an overall picture

Activities 1	Civilian Labor 2	Military Labor 3	Info. Tech. 4	Facilities 5	Material 6	Other 7	Activity Cost ($M) 8	Activity Output (K) 9	Unit Cost ($) 10	Opns. (%) 11
A1	100	240	50	30	120	40	580	50	2.90	100
A2	200	80	40	45	50	15	430	40	8.60	0
A3	300	120	150	80	70	20	740	150	7.40	50
A4	400	70	10	20	40	10	550	100	5.50	10
A0	1000	510	250	175	280	85	2300			

Figure 12. ABC Worksheet, After ***Functional Economic Analysis Guidebook*****, 1993**

of the relational structure of the data involved in the process. Figure 13 is an example of a completed data model for a course registration process. Contained inside the levels of the data model are objects (e.g., a student), and their associated attributes (e.g., student name), relationships (e.g., matriculates in), and integrity constraints (e.g., enrollment type is either grade or audit).

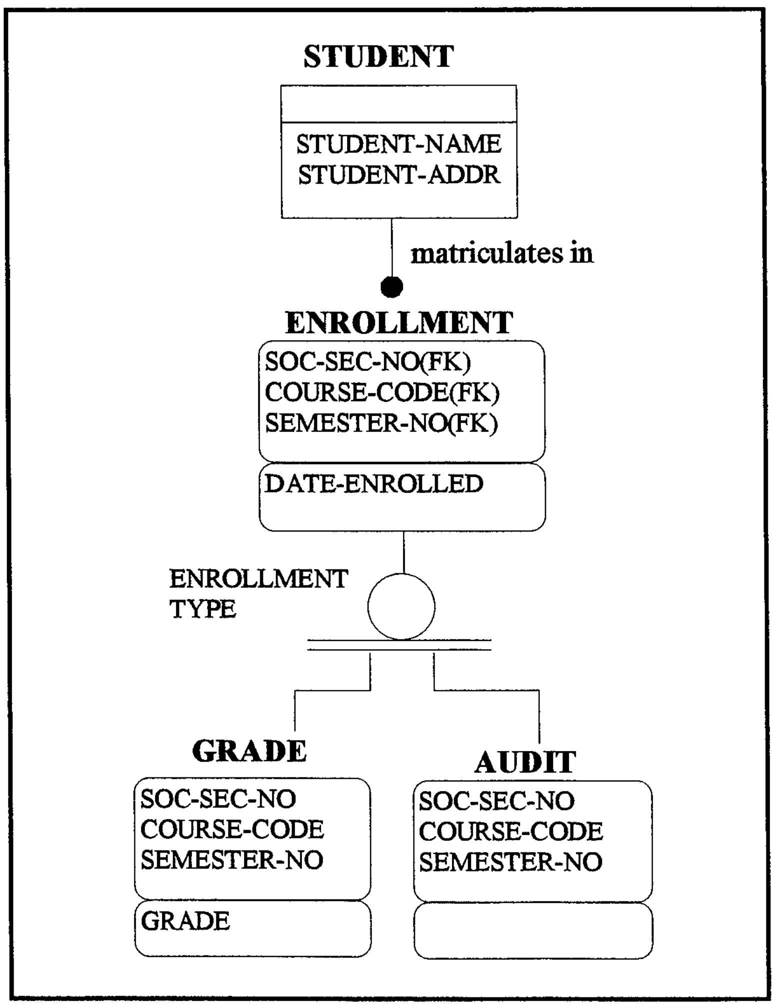

Figure 13. IDEFX Data Model, From *Design/IDEF 2.0*, 1992

3. Phase 3: Evaluate

In the third phase and its single step, Identify, Evaluate and Select Possible Improvements, opportunities for process enhancement are identified. This is accomplished by comparing the command's "as is" process models, Activity Cost Worksheets and performance record against its functional architecture and strategic plan. Each Activity Cost Worksheet entry is evaluated and emphasis is directed toward the activities that have high costs and/or low output, and those activities that have a high percentage of non-operational costs. (*Functional Economic Analysis Guidebook*, 1993)

Changes to the process and/or data models are identified based upon the value that a product or service provides relative to its production costs. Activities that do not add value to the overall process are:

> ...activities that create delay, excess, or variation in a process...Activity titles with the following words usually reveal non-value added activities: move, wait, check, review, verify, store, inspect, rework, record, and approve. (*Functional Economic Analysis Guidebook*, 1993)

Tasks that do not add value to the process are modified to add value or are deleted. Value added activities are also analyzed for possible improvement. Change to activity inputs, outputs, controls, and/or mechanisms are made to the activity model where appropriate. (*Functional Economic Analysis Guidebook*, 1993)

The value of a process can be determined by different measures. "In this context, the word 'value' includes the concepts of quality, customer service, flexibility, reliability, safety, security, and other benefits of our business process" (DODINST 8020.1-M, 1993). In order to compare the relative value of alternatives, effective measures must be identified for both quantitative and qualitative indicators:

> They (the measures) provide the framework for evaluating effectiveness and efficiency of an organization's business methods and the resulting operations. These measures permit comparative evaluation and

provide insight to the strengths and weaknesses of operations. (DODINST 8020.1-M, 1993)

Present processes are also benchmarked against successful processes found at similar organizations. "Benchmarking helps to identify desirable changes, eliminate inadequate proposals, and assess the reasonableness of costs and savings projected for those proposals that are brought forward for consideration" (DODINST 8020.1-M, 1993).

After possible changes are identified, a Functional Economic Analysis (FEA) is performed to determine the future costs of the alternative improvements. A separate Activity Cost Worksheet is prepared for each alternative for each the upcoming six fiscal years. Alternatives are again compared and ranked in terms of performance and cost over the six year period. The results of this analysis will be used to develop the final FEA document that is submitted for project approval.

An automated tool is available from DISA that can be used to complete the FEA. TurboBPR 1.0 is a program based on Microsoft Excel that contains electronic Activity Cost Worksheets and other forms necessary to record project goals, activity costs and performance measures. The software automatically generates graphs that depict the future costs and performance of alternatives. Figure 14 is a performance chart that shows the actual performance of an alternative, the activity's baseline level prior to the change, and the performance target level. (*TurboBPR 1.0*, 1995)

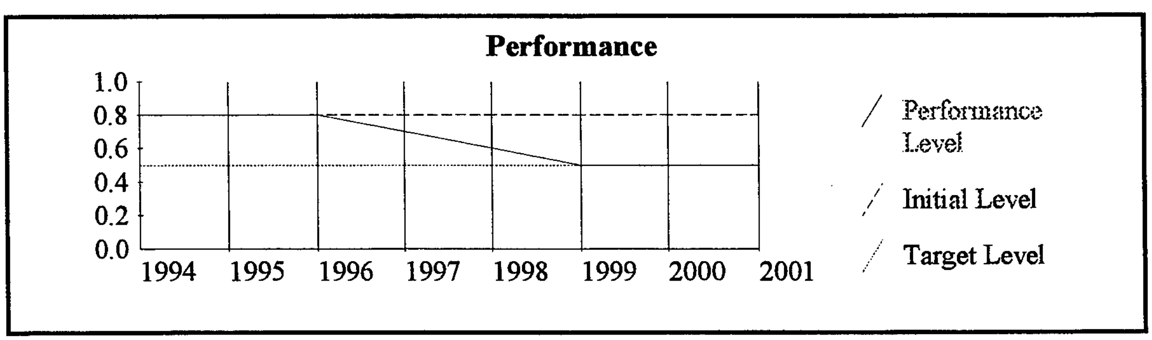

Figure 14. TurboBPR Performance Graph, From *TurboBPR 1.0*, 1995

Following the FEA, change alternatives can also be evaluated by the use of simulation tools. Process simulation tools model the flow of data and other resources through a functional activity. They focus on the dynamic constructs of a process that are not depicted in data or process models:

> Activity models are incapable of assessing flow rates, bottlenecks, idle time, throughput, cycle times, workload, and other dynamic properties. Since these dynamic properties often are of greatest interest to management, simulation becomes a key analytical tool. (*Functional Process Simulation: A Guidebook*, 1993)

The benefits of simulation are many. It provides a simple representation of a complex process that may be easier for management and user personnel to understand. It reveals bottlenecks that are shortages in resources, and also identifies underutilized and wasted processes and resources. It supports "what if" analysis by testing the effects of a change on a process without the expenditure of actual resources or time. Simulation also allows synchronization issues to be addressed and manipulated to ensure the best flow of information and products from one activity to another. Issues of coordination among interdependent, parallel processes can also be assessed. (*Functional Process Simulation: A Guidebook*, 1993)

Simulations require the use of detailed data. This data includes the time to complete a process cycle, the number of cycles to be completed in a scenario and the amount and cost of consumed resources. If this data was not previously collected in the process modeling step, it is now gathered and entered into the model. DISA has several simulation tools that can be used to aid in a FPI effort. One such program is SIMPROCESS, a CACI Corporation product written in SIMSCRIPT. (*Functional Process Simulation: A Guidebook*, 1993)

The identified change opportunities are then listed and ranked by their potential benefit to the organization. A table, such as Table 2, is created which records the applicable activity performance measures and the value of each measure for the baseline

Measure	Baseline	Alternative A	Alternative B
Unit Cost			
Error Rate			
Task Time			

Table 2. Comparison of Alternatives, After *Functional Economic Analysis Guidebook*, 1993

activity and each alternative form of that activity. At least two improvement opportunities are specified for each activity. (*Functional Economic Analysis Guidebook*, 1993)

Original activity models are modified as required to reflect changes to the baseline "as is" models. The actions, time and resources required to implement the changes are also identified and recorded. The updated models are referred to as "to be" IDEF0 models. (*Functional Economic Analysis Guidebook*, 1993)

4. Phase 4: Plan

Once improvement opportunities have been identified, analyzed and modeled, implementation action plans are generated for the best alternatives. In step nine, Generate a Data Management Plan, required data base changes are identified as well as probable impact of these changes upon the present system and its supporting data architecture. During the next step, Produce a Technical Management Plan, required procedural and information system infrastructure changes required to support the selected process improvements are delineated. Within the plan, time-phased modification schedules and costs are detailed. The plan will be used to control the development, enhancement, installation, operation, and migration of systems affected by the process changes.

5. Phase 5: Approve

Improvements to functional activities within DoD must be approved prior to implementation. The document that is sent up the chain of command for endorsement is a

comprehensive Functional Economic Analysis (FEA). This document is prepared as step ten of the FPI methodology. It includes the eight sections shown in Figure 15, which are composed of materials produced in previous steps. It is a refinement of the abbreviated FEA constructed in step seven and is used to support a detailed improvement proposal.

Section 1: Functional area strategic plan
Section 2: Functional activity strategic plan
Section 3: Functional activity performance measures and targets
Section 4: Proposed functional activity improvement program
Section 5: Economic analysis of the proposed process improvements
Section 6: Data management and information system strategy
Section 7: Data and system changes to support the functional process
Section 8: Data and system cost analysis

Figure 15. Sections of the FEA, After *Functional Economic Analysis Guidebook*, 1993

6. Phase 6: Execute

Once approval has been obtained for the change plan, new policies and procedures are implemented in step eleven, Execute Changes. In step twelve, Develop Information Systems, any required changes or new information systems are developed and installed to support the new procedures. Both the new processes and supporting information systems are monitored for their effectiveness in attaining their strategic objectives. In step 13, Revise Baseline, baseline documents from the initial stages of the FPI program are replaced with the newly approved process plans. These documents are now the starting point for continuous process improvement initiatives. Within the final step of the FPI Methodology, Improve Program Oversight, approved change plans are assessed by the

governing authority and DoD FPI program policies, methods, tools and procedures are analyzed for possible improvement. Functional improvements are also analyzed for possible duplication across DoD.

D. EVALUATION OF THE FPI METHODOLOGY

DoD's methodology meets all of the requirements of an effective methodology that were delineated on page 37. The FPI methodology is quite comprehensive and logically ordered. The component phases of the FPI methodology are similar to the BPR methodologies of Klein, Davenport and Harrington. Table 3 shows a comparison of the stages of FPI methodology with the methodologies previously discussed in Chapter II.

The phases of the FPI methodology are composed of detailed steps that delineate how to conduct process improvement from the establishment of the change program to the implementation of the new process and its supporting infrastructure. The cyclic nature of the methodology emphasizes the need for continual process analysis and improvement. The final step of the methodology, Improve Program Oversight, incorporates a feedback system into the overall reengineering program of DoD. As a result of this step, any lessons learned from the enactment of the methodology are used to improve the FPI process. The inclusion of activity based unit costing and the use of benchmarking to determine specific process performance measures are effective tools for the comparison of process improvement alternatives. The method also considers the limitations of present information systems and generates a migration strategy to a new supporting infrastructure.

The FPI methodology, however, does not address the importance of gaining management sponsorship. It also does not include any discussion of organizational changes required to support the new process or any mention of change management. These areas may have been overlooked due to the structure and authoritarian nature of military organizations wherein employees are expected to follow the directives of senior organizations without hesitation or questioning.

BPR (Klein)	BPR (Davenport)	BPR (Harrington)	FPI (DoD)
Preparation	Identify Processes for Innovation, and Identify Change Levers	Organize for Improvement	Define
Identification	Understand Existing Processes	Understand the Process	Analyze
Vision	Develop Process Visions	Streamline	Evaluate
Technical and Social Solutions	Design and Prototype	Streamline	Plan and Approve
Transformation	Design and Prototype	Measure and Control, and Continuous Improvement	Execute

Table 3. Comparison of BPR Methodology Phases

The FPI methodology is a consistent procedure to use for reengineering projects and it could easily be applied to any business process. Its steps are easily understood and followed because the FPI methodology is supported by in-depth documentation, training manuals and specific automated tools. The inclusion of a simulation tool allows the test and evaluation of the improved process prior to its implementation.

The incorporation of automated activity modeling is another strength of the FPI methodology. The graphical representation of activities is a necessary part of reengineering. "Many organizations reengineer without using process-analysis tools, but adding process modeling to the reengineering effort nearly doubles the probability of success..." (Wallace, 1994). An activity model, by breaking down the process into its

component tasks, provides an easy to understand visual depiction of the present and possible states of a process. It also removes ambiguity from any process descriptions by the use of standard notations.

The IDEF0 activity modeling tool specified for use during FPI, however, might be difficult for a reengineering team to learn and operate. IDEF0 models may be too complex and technical for a user to build and manipulate due to the use of unfamiliar constructs. Also, an IDEF0 model does not capture all of the data required to conduct process reengineering. The cost and time values associated with a task are not contained as a part the activity model. The business rules that govern a process can only be included on an IDEF0 diagram as textual annotations. Sequencing and task prioritization must be interpreted from the rule annotations and can not be determined directly from the picture of the process.

There are presently three separate automated tools used to support the FPI methodology: IDEF for activity and data modeling, TurboBPR 1.0 for cost analysis and a tool such as SIMPROCESS for process simulation. At this time, DISA does not possess a tool that single-handedly supports activity and data modeling, economic analysis and model simulation. The use of three independent tools requires the redundant entering of data and additional computer operator time and skills. Also, none of these tools provides real time measurement of process performance statistics such as work status, cost or process completion time. The process analysis is conducted using only historical data.

An automated tool is required for reengineering that consolidates process modeling, cost analysis and simulation. An automated workflow management tool automates the performance, routing and management of the work of a process, and measures process performance indicators on a real-time basis. The use of a workflow management tool not only streamlines the reengineering procedure for the change team, but also improves the business process through the automatic transfer, assignment and completion of work. The following chapter discusses workflow modeling and the functionality of automated workflow management technologies.

IV. WORKFLOW MANAGEMENT

This chapter provides an overview of workflow management. It begins by defining the types of workflow and the components of a workflow model. It then discusses automated workflow management technologies, their evolution, functionality and market. The next two sections discuss the benefits of, and obstacles to, the implementation of workflow management tools, respectively. Finally, it examines and evaluates these workflow model design methodologies.

A. TYPES OF WORKFLOW

A workflow is an ordered collection of tasks that, when linked together, forms a business process of an organization. Workflow, in its manual form, is not new. The progression of work and its supporting information from one employee to the next has always required management. (Koulopoulos, 1995)

There are three types of workflow: ad hoc, administrative and production (Eckerson, 1993). They are categorized by the structure and level of complexity of the processes they support. These three types of workflow have also been referred to by other authors as unstructured, structured and complex, respectively (Creative Networks, 1994). Figure 16 depicts the differences between the types of workflow based upon their business value and operational breadth within the corporation.

1. Ad Hoc

Ad hoc workflows are composed of unstructured tasks for which the controlling business rules are not known or change too rapidly to track. This work is often completed by individuals or small work groups formed solely for the fulfillment of a specific task. The value of the process to the business is relatively low. These processes are unique or dynamic and, therefore, fixed workflow models are not maintained. An example of an ad hoc workflow would be the planning of a one-time ceremony for visiting dignitaries.

2. Administrative

Administrative tasks have minimal structure and are not complex. They are simple processes that do not frequently change. Because they have some structure and stability, they can be modeled; however, the models may require frequent updating. Administrative processes contain tasks that are completed by a team or workgroup. This work is of moderate value to the business. An example of an administrative workflow would be the submission and processing of an expense report.

3. Production

Production based workflows, also known as transaction workflows, involve highly structured and complex tasks. These processes entail high volume, mission critical and repetitive work. Within these processes, work regularly takes a well-defined path through the organization. The business rules that regulate the production workflows are well known and, therefore, a standard process model can be defined and recorded. Mortgage processing is an example of a production workflow.

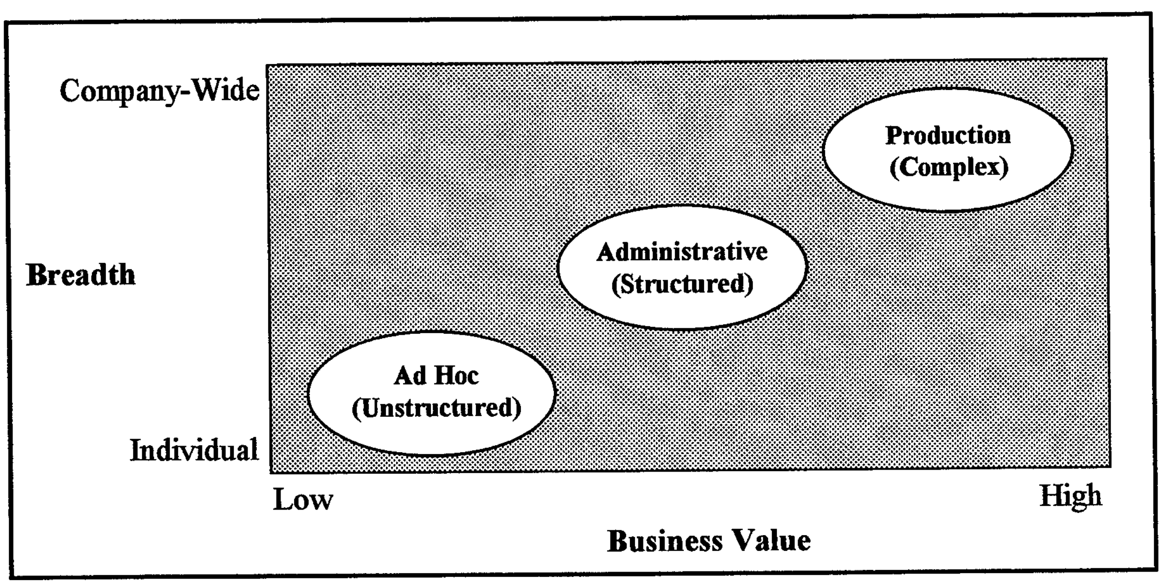

Figure 16. Workflow Types, After Creative Networks, 1994

B. COMPONENTS OF A WORKFLOW MODEL

A workflow model is a graphical representation of a process. It is used to document the flow of work through a business cycle of an organization. It consists of several components: a work breakdown structure, work objects, roles, rules, resources, time and routing. Figure 17 shows the relationship between these components.

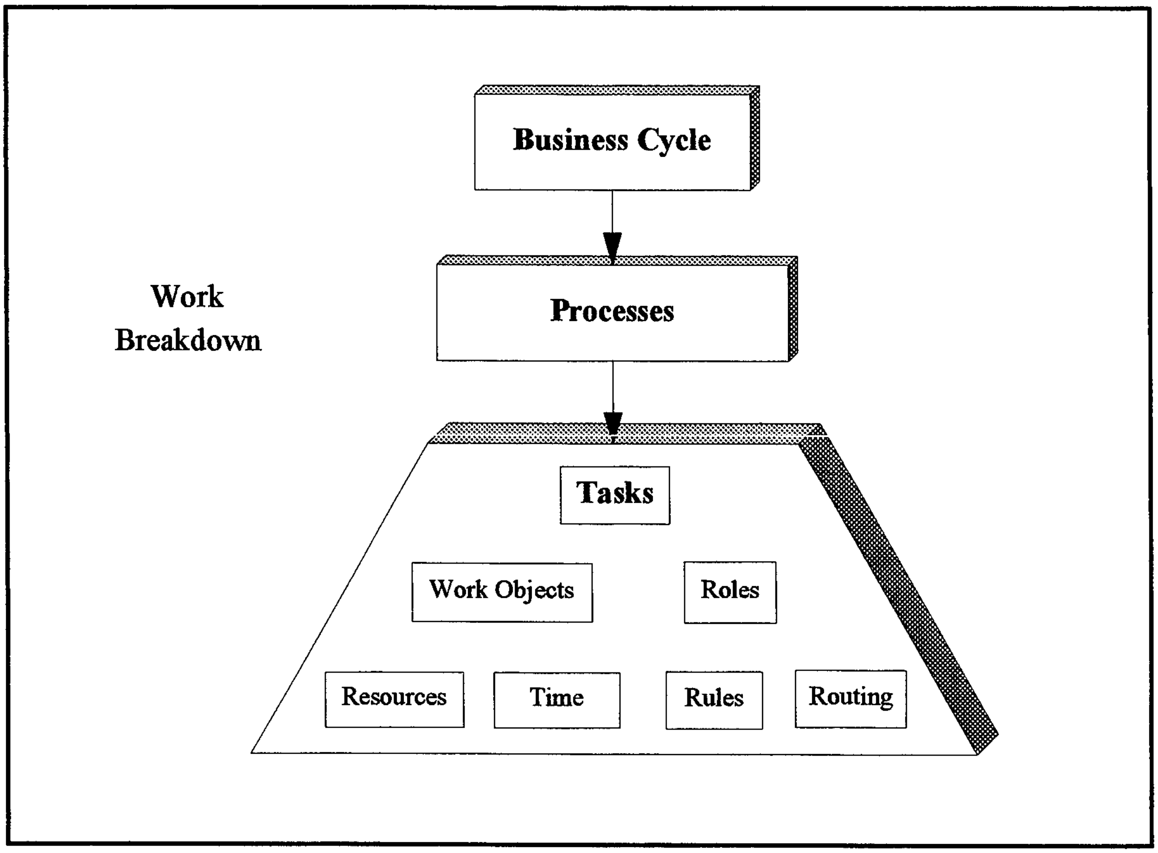

Figure 17. Components of a Workflow Model

1. Work Breakdown Structure

A business cycle is an overall objective of an organization. It represents one of the company's purposes for existence, at its highest level of abstraction. For example, a business cycle of a bank would be *lending money*. (*Workflow•BPR User's Manual*, 1995)

A work breakdown structure is a graphical depiction of the hierarchical structure of a business cycle. It decomposes a business cycle into its component parts. Figure 18 is an illustration of a portion of the breakdown of a business cycle. The goal of this decomposition is to represent the work of an organization in simple and easy to understand component pieces:

> The best thing about these graphic representations is that you can represent complex processes at a high level of abstraction. Then, by employing drill-down capabilities, users can explore the process in detail...This type of graphical representation becomes particularly important when you need to ensure that everyone -- users and developers alike -- completely understands the processes and their components. (Koulopoulos, 1994)

Within the work breakdown structure, a business cycle is broken into processes. A process encapsulates the start to finish work required to create a business product or service. For example, a process within the business cycle of *lending money* would be *mortgage processing*. Each process is, in turn, split into sub-processes or directly into tasks. A sub-process is a more detailed segment of the overall process. Examples of possible sub-processes of mortgage processing would be *processing the mortgage application* or *closing on the mortgage*.

A process, or sub-process, is then broken into tasks. A task is the lowest level of an activity. It is therein that the actual work steps of a process are completed. An example of a task would be the *verification of the completeness of a mortgage application form*. Each workflow task consists of several components: work objects, roles, rules, resources, time and routing.

2. Work Object

A work object is the input to, or product of, a task. It is any item that is routed between tasks and/or workflow participants. Work objects take various forms. The

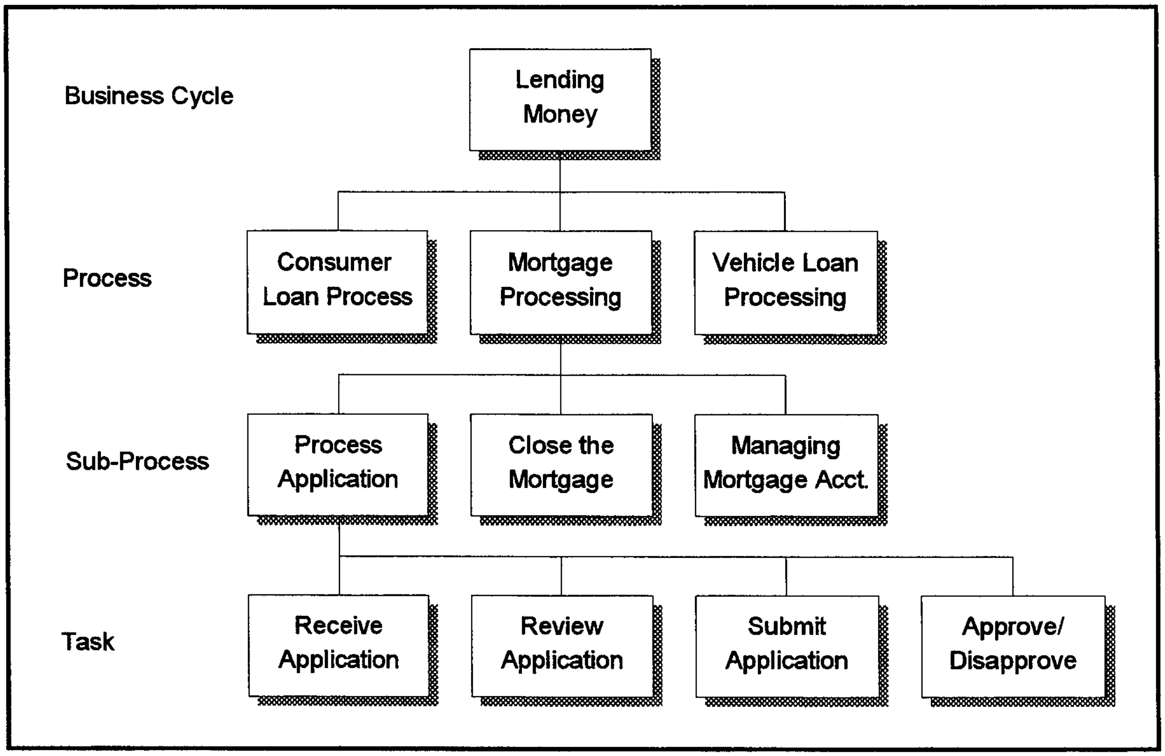

Figure 18. Example of a Work Breakdown Structure

object may be a physical resource used to create a product or service, or the product or service itself. It may also be a paper or electronic document that contains information structured in such a way as to have meaning to an organization. For example, a *mortgage loan application form* is a physical work object that is an input to the task *Receive Application*. (Koulopoulos, 1995)

3. Roles

The roles of a task are the participants in the activity. They include the people in a corporation who perform the work steps, as well as the suppliers of resources and business customers. Personnel are not designated by name in the workflow model. Roles are assigned by position titles so that a change to a personnel assignment does not require an associated update to the model's data repository. A cross referencing table can be

added to the repository to associate a particular position with the person filling it at a specific time.

4. Rules

The rules of an organization describe the behavior of task participants. They define what work is completed within a task and why, where, when and how the work is accomplished. Business rules include information concerning (Koulopoulos, 1995):

- **Task Initiation:** What action or event triggers a task?
- **Task Dependency:** What things must occur prior to the initiation of a task?
- **Notification:** Who is notified upon the receipt or completion of work, when and why?
- **Role Definition:** Who is involved in a task and who completes the work?
- **Task Automation:** Which tasks can be automated and which can not be automated and why?
- **Product Form:** In what format and media is the product or service to be presented?
- **Scheduling:** By when must each task be completed?
- **Priorities:** Which tasks are most important and must be completed before others?
- **Authorization:** Who must approve actions taken during the completion of a task?
- **Resource Consumption:** Which and what amount of resources can be and are used to complete the task?
- **Security:** What level of physical or information security applies to the task or work object?
- **Work Completion:** What and who determines that a product is finished and work is complete?
- **Task Iteration:** What portions of a workflow are repeated and what rules may change as a result?
- **Routing:** Where, when and how is the input to, and output of, a task sent?

5. Resources

Resources are the items consumed in the course of conducting business. They are the input used by an employee to complete an assigned task. Material, money, personnel assets, equipment, and facilities are all examples of resources. (*Workflow•BPR User's Manual*, 1995)

6. Time

Time is also a resource consumed during the completion of a task. It is an extremely important aspect of a workflow; therefore, it has its own category in the workflow model. A process of a business cycle takes a certain amount of time to complete. The cycle time is a combination of the time it takes to actually complete a task (task time) and the time required to transfer the work objects to the next task in the workflow (transfer time). (Koulopoulos, 1995)

Cycle time affects the overall efficiency of a business process. It has been found that about 90% of the cycle time is composed of transfer time alone. Only 10% of the cycle time is spent actually accomplishing a task. (Koulopoulos, 1995) "Transfer time is customarily ignored during an analysis of existing procedures because the focus tends to be placed on the people and the tasks, not on the time that passes between the completion of individual tasks" (Koulopoulos, 1995).

Transfer time can be broken down into physical transfer time and queue time. Queues are holding areas for work objects or assignments that are waiting to be processed. A queue can result for several reasons. An employee may temporarily hold work while awaiting the arrival of required resources or information, or awaiting the rendezvous of another work object to so that the objects can be forwarded together. He/she may also set low priority tasks aside while higher priority tasks are completed. Also, the employee may be a slow or incompetent performer. Figure 19 shows the components of cycle time.

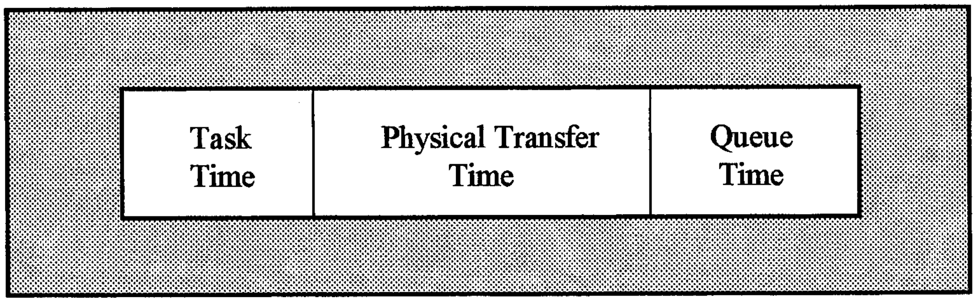

Figure 19. Components of Cycle Time

7. Routing

Routing is a depiction of the logical arrangement of tasks and the flow of work objects between them. Tasks can occur in series or in parallel. "IT (Information Technology) with its ability to facilitate sharing of resources like databases can break up traditional linear processes and allow them to occur simultaneously" (Grover, Fiedler and Teng, 1994). Routing can also be conditional, with the flow dependent upon the initiation or completion of other tasks, or upon the results of a decision. (Koulopoulos, 1995) The process may contain a cycle of tasks whose completion depends on the satisfaction of some condition. Work objects can also be broadcast simultaneously to all personnel. Figure 20 depicts the types of routing.

In a workflow model, routing is established by pre-defined routing rules. Exceptions to these rules are managed by modifying the original model or by the use of subflows.

An example of a portion of a workflow model is provided in Figure 21. Within the model, work objects are represented by circles. External roles are depicted by rounded rectangles and internal roles are written above the rectangles. Rules are incorporated into the decision node, represented by a diamond. Routing is depicted by the arrowhead lines connecting each figure in the model. Time and resources are not shown in this example, but would be captured in a data repository.

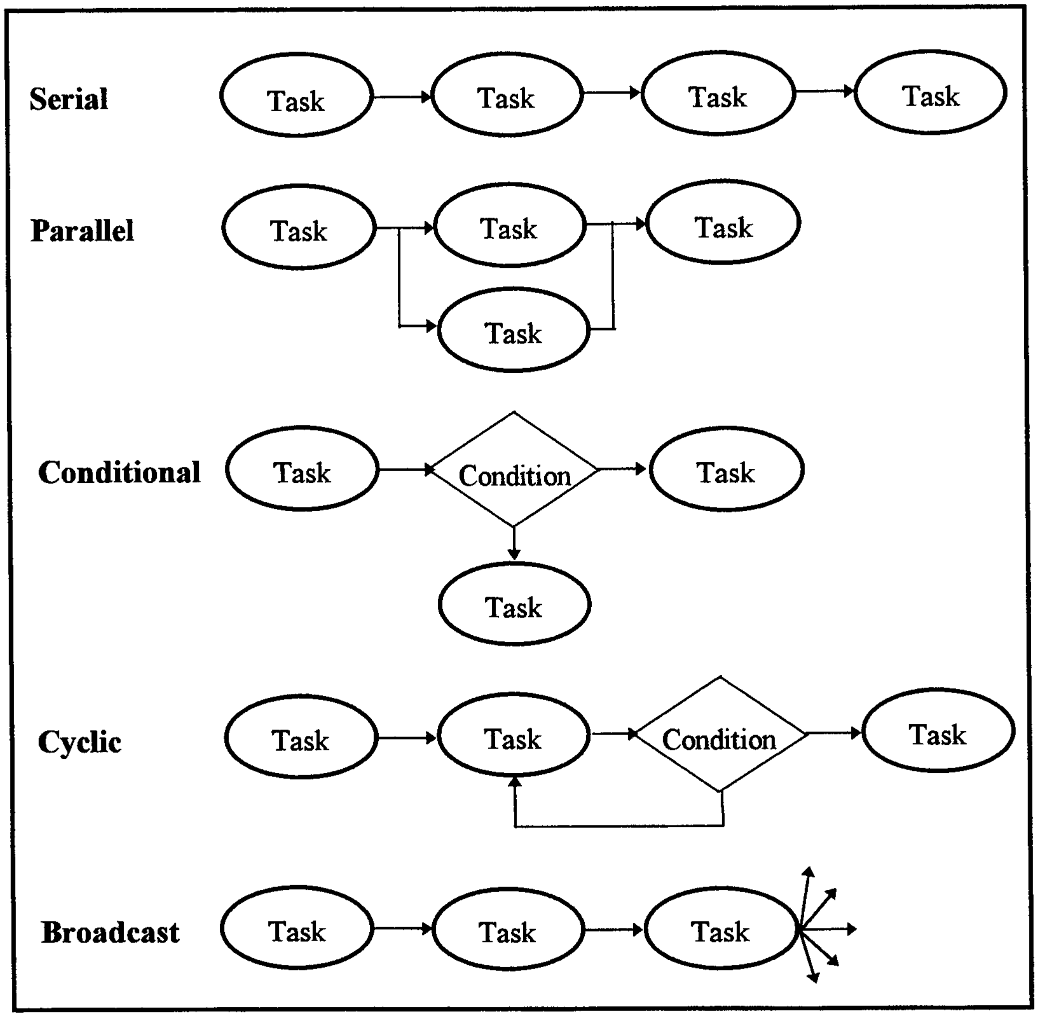

Figure 20. Types of Routing, After Koulopoulos, 1995

C. WORKFLOW MANAGEMENT AUTOMATION

The widespread use of computer technology has facilitated the automation of many white collar office tasks. However, many of the work steps automated were outdated or inefficient, resulting in quicker, not better, completion of work. Consequently, productivity gains have not kept up with the investment made in the supporting electronic infrastructure. "This stands in stark contrast to factory automation, where investment in computing technology has dramatically increased the manufacturing output for each worker" (Silver, 1994).

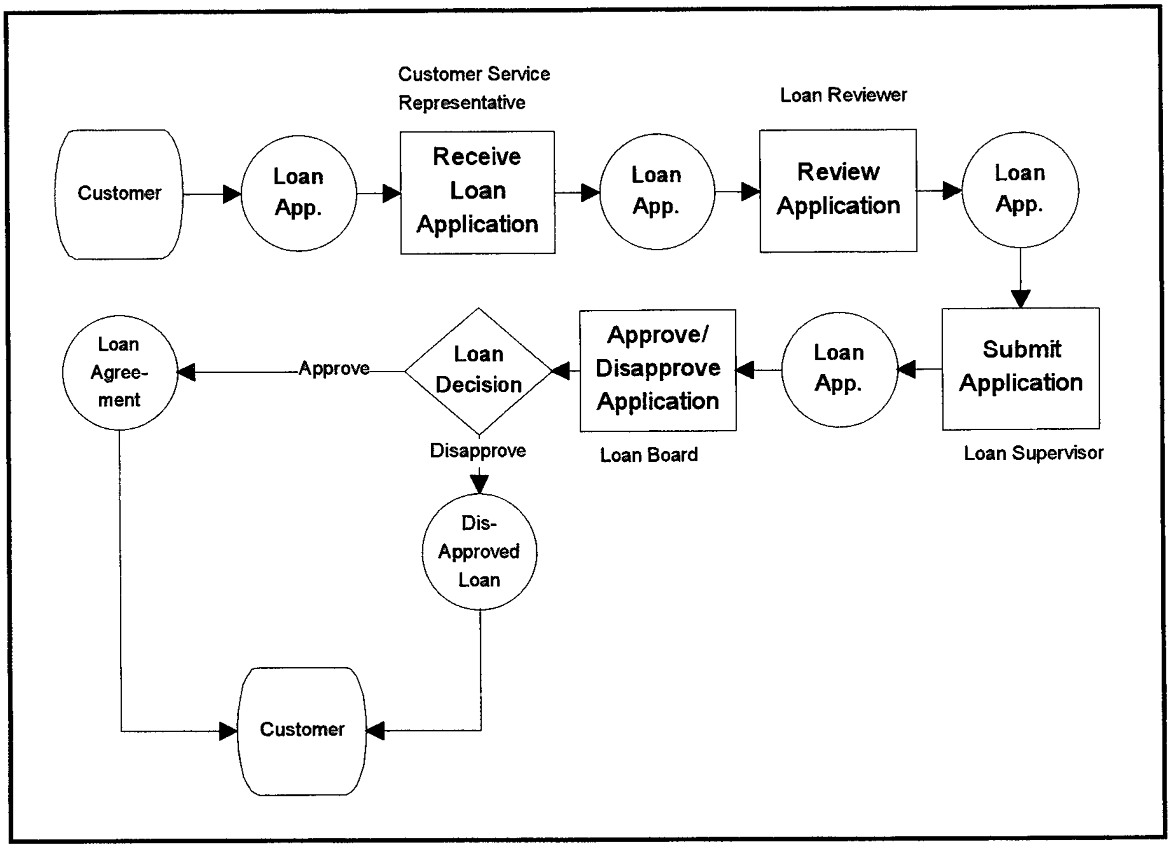

Figure 21. Example of a Workflow Model

Business leaders have recognized that the difference in returns on investment is due, in part, to organizational focus and structure. Successful factory managers arranged their assembly lines and supporting work units based upon the flow of the products they generated. White collar office managers, however, focused on employee skills and organized their departments by these specialties into hierarchical structures. As a result, the office automation systems installed in each functional department encompassed only that organizational segment's internal operations. There is a growing "...recognition among business and information systems executives that competitiveness in the '90s demands automating the entire *process* of a business activity, not just the individual discrete tasks" (Silver, 1994).

1. Definition of Workflow Management Software

Just as the assembly line revolutionized the factory, workflow management software is a new tool that is transforming the office environment. Workflow management software is a computer application that enables the electronic transfer and management of information and work throughout an organization's business processes using client-server technology. This work coordination occurs across organizational boundaries, both vertically and horizontally. (Koulopoulos, 1995) In this way, a workflow management tool makes an organization look like a factory:

> WORKFLOW AUTOMATION systems are the assembly lines of the electronic information age. Using your existing LAN (local area network) infrastructure, they employ rules-based logic to systemize and speed up your business processes, moving and coordinating data within the workgroup. (Bragen, 1994)

Workflow encompasses not only a software package, but a new set of tools and methodologies for managing business processes.

2. Evolution of Workflow

Initial personal computer systems were limited to independent software tools installed on stand-alone machines. These systems supported the needs of an individual worker. This person could operate within only a single software application and could not electronically communicate or work with other employees. (Koulopoulos, 1995)

As technology developed and computers became more powerful, integrated suites of software products were developed that allowed one person to use a set of multi-function tools. This created an independent office system wherein an employee could use word processing, spreadsheet and graphical applications to complete a single task.

The introduction of local area networks into the office environment made concurrent group work possible and spawned the production of groupware and electronic

mail products. Using these tools, several workers simultaneously employ a single software application to complete a task.

Workflow management software expands the capability of a network by facilitating the concurrent use of several different tools by many users. Each user has a single point of access to the tools via their "electronic desktop." Their computer screen contains all the applications, grouped by process, necessary for the employee to perform an assigned task. Figure 22 shows the relationship of software products to the number tools supported and the number of people using the tool(s).

		People	
		One	*Many*
Tools	*One*	Individual	Workgroup
	Many	Office	Workflow

Figure 22. Evolution of Workflow, After Koulopoulos, 1995

Workflow tools originally entered the market in the early 1980s as part of document management and imaging products. They were used primarily to route and catalogue document images. "The main thrust of these first-generation workflow systems was to enable electronic flow of digitized documents from one processing step to the next" (Bragen, 1994). Present workflow applications, however, have expanded the

original use to include the manipulation and transfer of text and other forms of media. Ultimately, workflow will become an integral part of computer operating systems:

> Workflow is undergoing a transformation. It is slowly becoming a fundamental building block of information systems. Development has already begun to integrate workflow capability into operating systems. Eventually, users can expect their systems to automatically forward documents and work objects to the right people at the right time. (Mayer, 1994)

3. Workflow Management Software Functionality

Comprehensive workflow management packages share basic functionality such as automatic work routing, distribution, prioritization, tracking, management reporting and process simulation. (Silver, 1994)

a. Work Routing

Workflow management tools electronically deliver work, and a notification of its arrival, to an employee's electronic desktop. When the job is received, it is added to the employee's work queue and an alert is displayed on their computer screen. When the job is completed, the workflow tool automatically routes the work object to the next pre-defined task in the workflow model. This routing is based upon the rules specified during the design of the workflow template:

> Users invoke queued work items through a graphical depiction of the workflow. Once the work queues are invoked, the system dynamically assembles the environment, the data, and the task logic, which invokes the next related task within a larger process. (Howard, 1994)

b. Dynamic Work Distribution

Workflow software allows tasks to be assigned to a category of workers, instead of a particular position title. The workflow tool monitors the workload of each

employee filling a position of that type. A new work package is then dynamically assigned and routed to the first available employee or the employee with the lightest workload. This alleviates the need for the workflow designer to predetermine which individual should be sent a work object. For example, an insurance company may have a pool of several automobile claims adjusters. When a new automobile claim is received, the workflow tool automatically determines which of the adjusters to give the task to based upon what jobs are in their queue.

The workflow tool can also be programmed to monitor the queue size of each employee. When a queue grows to a certain size, work can be pulled from that employee and rerouted to another employee of the same type who has a smaller queue. These work balancing features ensure that important tasks are not left in a queue waiting for a particular individual, thereby decreasing job completion time.

c. Work Prioritization

Workflow tools enable the prioritization of tasks. The first assignment received in an "in" box is not always the most important one to first complete. The timely fulfillment of another task might have a higher impact on the overall success of the business cycle. For instance, for a clerk in a travel agency, the processing of a last minute travel request would be far more critical to a customer, and hence the business, than the handling of a routine travel claim. The workflow tool places work into an employee's electronic "in" box, sequencing the jobs based upon their pre-assigned priority levels.

Dynamic work prioritization is also supported by some workflow tools. The workflow engine can monitor and upgrade the priority of a task based upon the length of time the job has spent waiting in a queue, or based upon any other pre-defined variable. For example, if an insurance claim sits in an adjuster's "in" box for over five hours, the workflow tool can be programmed to increase the priority level of that assignment at the sixth hour of waiting. This makes the job more urgent and moves it ahead of other tasks

in the "in" basket. Some tools will also sound an audible alarm when a job is nearing its deadline for completion.

d. Work Tracking

Workflow management tools monitor and record the performance of work within the workflow model. Several performance measures are kept such as task cost, time, status and location. Workflow tools allow the generation of instantaneous reports on the status of a work object. A manager can quickly query the tool for the location, responsible employee, waiting time and completion status of a particular item. Considering the data reported, the manager can reroute work packages or change the priority of task completion.

e. Management Reporting

Because workflow tools maintain up-to-date statistics on work completion, real-time reports can be generated to answer questions concerning average process completion and queue times, resources consumed and their costs, and overall productivity rates:

> A good workflow tool generates on-line reports that offer insight to the workloads, bottlenecks, resource allocation, throughput, productivity, and the overall business cycle. By analyzing these, immediate decisions can be made to alter a process by re-allocating resources, changing task relationships, eliminating redundancy, or altering priorities of work. (Koulopoulos, 1995)

Workflow reports can also be generated by employee and used as a performance diary.

f. Workflow Simulation

A relatively new and promising feature offered with workflow tools are simulation tools:

> Workflow simulation tools allow designers to test workflow processes and to identify problems with the process before the workflow application is implemented. At the present time, very few workflow systems provide these facilities as part of the workflow product. (Koulopoulos, 1995)

Simulation capabilities are becoming more important to workflow customers; hence, they should become more prevalent in workflow products in next two years. (Delphi Consulting Group, 1995)

There are four types of simulation. They are, in order of technological advancement, verification, rule-based, statistical and heuristic. A comprehensive tool would enable all of these types of simulation. Verification tools examine a workflow model for completeness. This tool will tell a designer if work object flow lines are missing, or if there is no input to or output from a task. Rule-based simulation tools validate the logic used in specifying routing rules. These types of tools are found in many of the low-end workflow packages. (Delphi Consulting Group, 1995)

Statistical simulation tools enact instances of the workflow template, randomly taking different conditional paths through the process. The tool gathers performance data for each workflow enactment, identifies possible bottlenecks or queues, and reports the utilization of resources. This type of simulation is presently found in high-end workflow products.

A final type of simulation is heuristic. This tool improves and updates the workflow model on a real-time basis in response to the performance statistics gathered during the simulation. As of now, no tools exist in the heuristic category.

4. Workflow Software Modules

There are three distinct software modules in a comprehensive workflow application: a workflow builder, deployment environment and engine. (Marshak, *Distributed Computing Monitor,* 1994)

a. Workflow Builder

The workflow builder is the environment wherein the workflow model is depicted and stored. A graphical process modeling tool and a supporting data dictionary is provided to illustrate and record the workflow. There are a variety of process model builders available that are aimed at different employee skill levels, including flowcharting and graphical mapping tools. The workflow builder helps the designer, user and sponsor visualize and, thereby better understand, a process. The process model also enables users to see where their duties and assignments fit into the overall process and how their actions affect others and the final product or service.

Using the builder, the designer delineates all of the components of a workflow model: the work breakdown structure, work objects, roles, rules, resources, time and routing involved in a process. The builder is visible to the designer but may be hidden from the user. In some instances, specified users who are authorized to modify workflow templates may have access to the builder's design features.

b. Workflow Deployment Environment

The workflow deployment environment is the "electronic desktop" that users see and manipulate when operating within a workflow management system. Icons located on the computer screen are labeled by process name. Contained within each process are the particular software applications and electronic work objects and resources that an employee needs to complete the assigned task. The deployment environment also includes work notification lists, files, and direct access to software applications and electronic mail.

c. Workflow Engine

The workflow engine is the workhorse behind the workflow tool. It manages each instance of a business process, controlling work tracking, routing and rule enforcement. It also runs workflow simulations and generates reports on gathered

performance measures. The workflow engine is hidden from the users as well as the workflow template designer.

5. Workflow Operating Platforms

According to the results of a 1993 survey conducted by the Delphi Consulting Group, 97% of organizations having implemented workflow applications deploy it on a client-server platform (Mayer, 1994). The majority of server platforms are UNIX based. Client platforms are mostly windows capable computers. Figure 23 shows a breakdown of the distribution of client and server platforms. (Delphi Consulting Group, 1993)

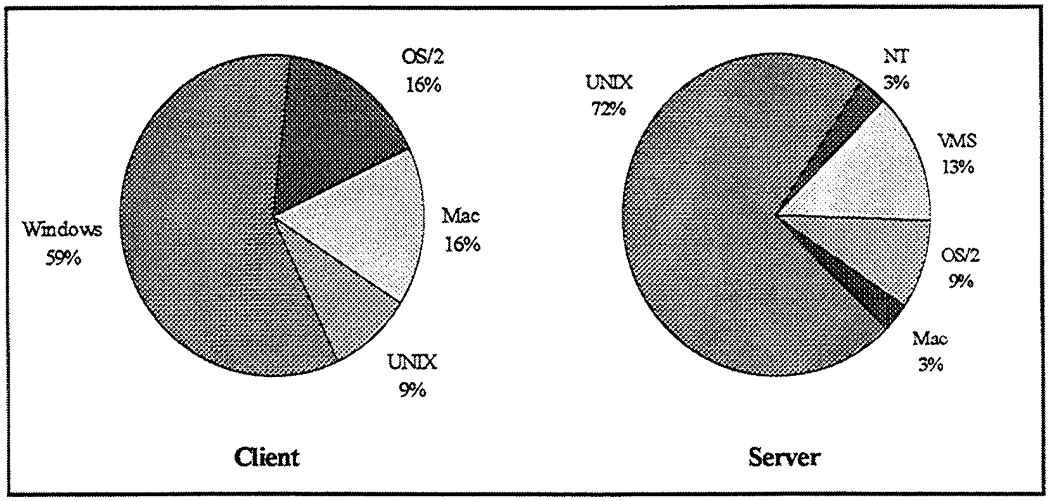

Figure 23. Workflow Client and Server Platforms, After Delphi Consulting Group, 1993

6. Types of Workflow Management Tools

There are over 140 software vendors who claim to incorporate workflow into their products (Marshak, *The Workflow Paradigm*, 1994). These workflow packages are categorized based upon the type of workflow they support (Kemsley, 1994). Figure 24 shows the types of workflow software, adding the ranges of application cost and the level of productivity improvement realized as a result of their use.

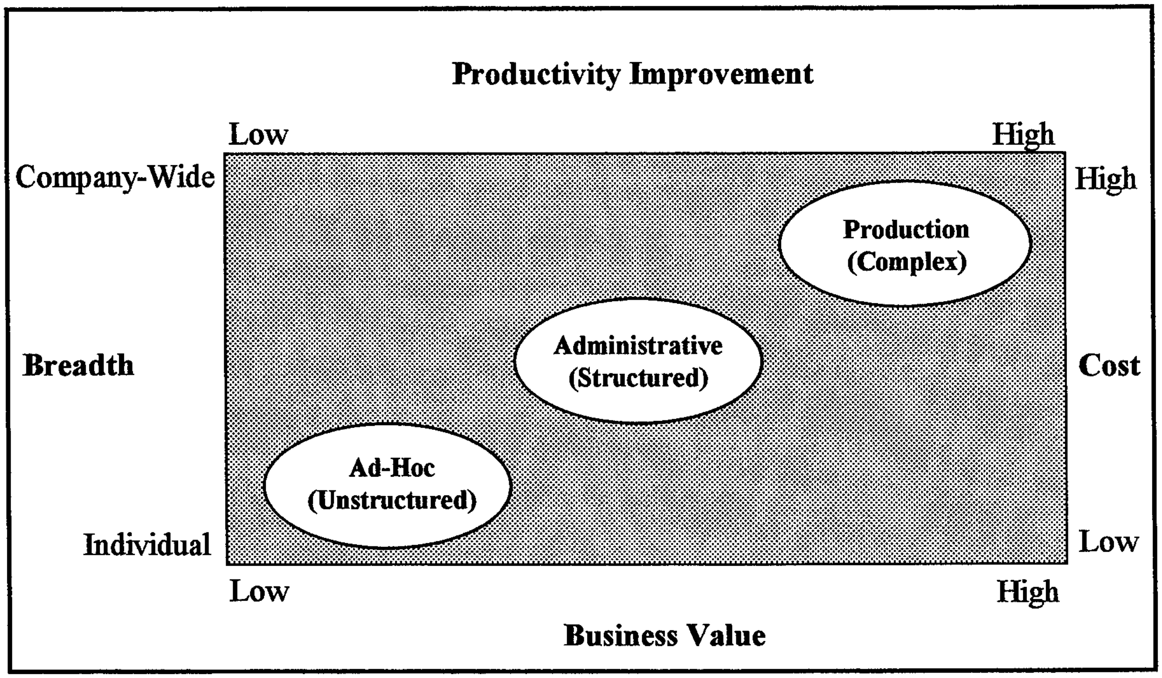

Figure 24. Workflow Automation Applications, After Creative Networks, 1994

Workflow products that support ad hoc workflows are low cost, aimed at project applications, and have a lower chance of improving productivity due to the non-structured aspects of the process (Creative Networks, 1994). It is impossible to design a static model due to the dynamic nature of these workflows. Ad-hoc workflows are "...often embellished e-mail functionality, the scripts for which may be created and discarded within a day or two" (Kemsley, 1994). These systems typically cost under $500 per user (Winkler, 1994).

Software packages that support administrative workflows are moderately priced, support workgroups, and provide moderate opportunities for process improvement. This type of workflow package ranges in price from $300 to $500 per seat (Winkler, 1994). An administrative workflow package provides "...more user interaction than unstructured workflows through alerts, reminders and instance status" (Creative Networks, 1994).

"Provided with a forms-based development environment, these systems can sometimes be customized by non-IT (Information Technology) personnel in the user department, then managed and modified to suit changing policy" (Kemsley, 1994).

Workflow packages that support production workflows are the most sophisticated and, therefore, the most costly. They range in price from $1,500 to $3,000 per user (Winkler, 1994). However, because production processes are the most strategic to the business and the software supports employees throughout the organization, there is a very high productivity improvement realized through the implementation of this type of workflow package. Production workflow, which currently holds the largest workflow market share, is often based upon integration with databases, instead of electronic mail. (Creative Networks, 1994).

Although the average workflow package costs $1,000 per seat, the total system cost of implementing automated workflow management averages $3,500 per seat. The additional $2,500 investment is for required hardware additions or upgrades, and implementation assistance, such as installation, integration and design consultation. As a result, an average-sized system of 100 users at $3,500 per seat would cost $350,000. Delphi Consulting Group found that only 16% of the businesses that installed workflow systems experienced total costs over $300,000. (Delphi Consulting Group, 1993)

7. Workflow Market

Workflow applications are relatively new to the computer software market. Delphi Consulting Group, a leader in the workflow industry, conducted a 1993 survey of 38 workflow vendors. They found that only about a third of these vendors' currently available products had been in existence for more than four years. Almost half had been available for less than two years. (Delphi Consulting Group, 1993)

Although workflow management technology is still in its infancy, the market for workflow products is rapidly expanding. An annual growth rate of 40% is predicted. If

this holds true, the market, which was estimated at $518 million in 1993, will become approximately $950 million by the end of 1995. (Delphi Consulting Group, 1993)

The largest customer segment in the workflow market consists of government agencies which account for 15% of market revenues. Banking and financial institutions make up 10% of the market; manufacturing businesses 8%. Figure 25 shows a breakdown of workflow market revenue by customer segment. (Delphi Consulting Group, 1993)

Delphi's market survey also included 400 businesses. Of these, 48% were service oriented, 20% were government and 16% were manufacturing organizations. Most of these companies (91%) were interested in incorporating workflow. Well over half (64%) of the companies surveyed had already examined workflow tools. Of the government agencies surveyed, 10% were implementing workflow, 32% were planning to install workflow and 48% were still evaluating workflow. (Delphi Consulting Group, 1993)

The average number of workflow users within organizations having implemented workflow is small. Only about a third of the business reported that workflow had been installed across their entire organization. They tended to employ systems that support single or multiple departments. In most cases, workflow systems have been limited to 50-100 users due to the complexity of analyzing and designing workflow templates. The majority of these users are professional staff (42%) and clerical workers (34%). Only 5% of executives and 19% of managers use the system. (Delphi Consulting Group, 1993)

D. BENEFITS OF WORKFLOW MANAGEMENT AUTOMATION

The workflow market has experienced its 40% growth due to the many benefits that workflow management automation provides to organizations:

> Downsizing, increasing competition, the globalization of markets and many other factors are forcing organizations of all sizes and in all industries to become more efficient, to better address customer needs, and to develop and bring products to market more quickly. Workflow automation software can help companies to achieve these goals and to measurably increase the efficiency of a wide variety of business processes. (Creative Networks, 1994)

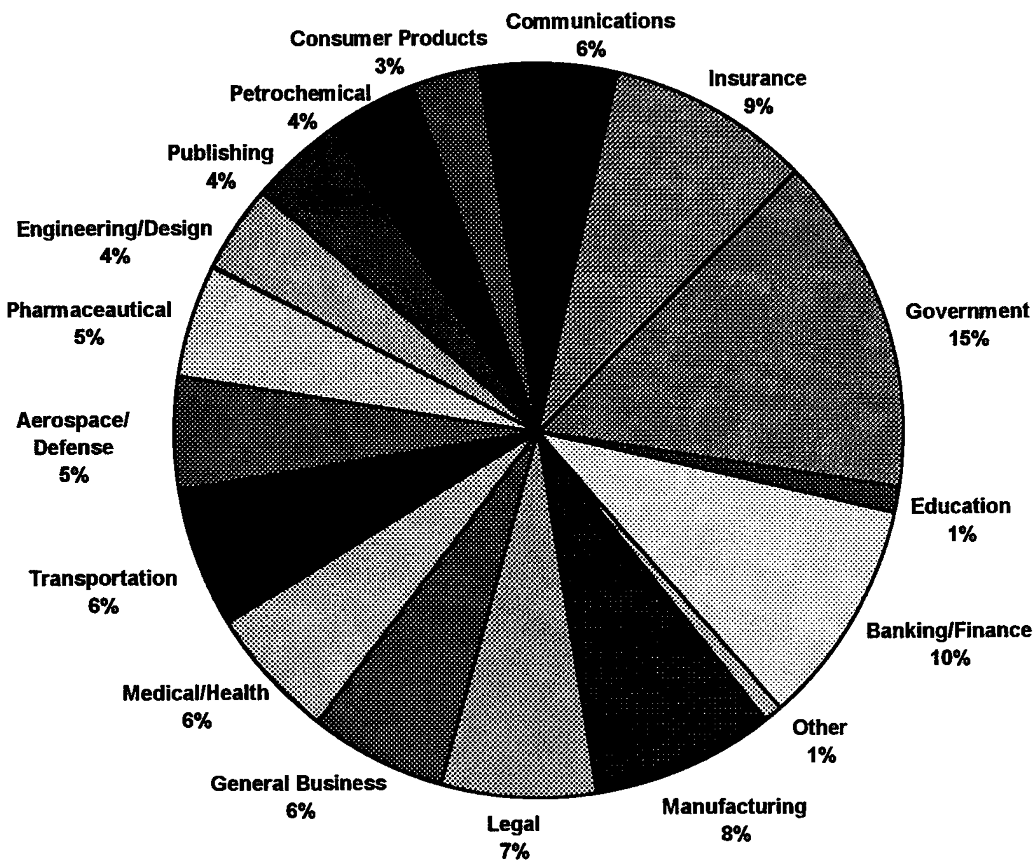

Figure 25. Workflow Market Revenues by Customer Segment, After Delphi Consulting Group, 1993

Specifically, Delphi Consulting Group reports that the leading benefits of workflow are (in descending order) increased productivity, heightened competitive advantage, reduced costs, increased communication, improved process control, reduced manpower, and support for process reengineering. (Delphi Consulting Group, 1993) Figure 26 shows the relative ranking of these benefits.

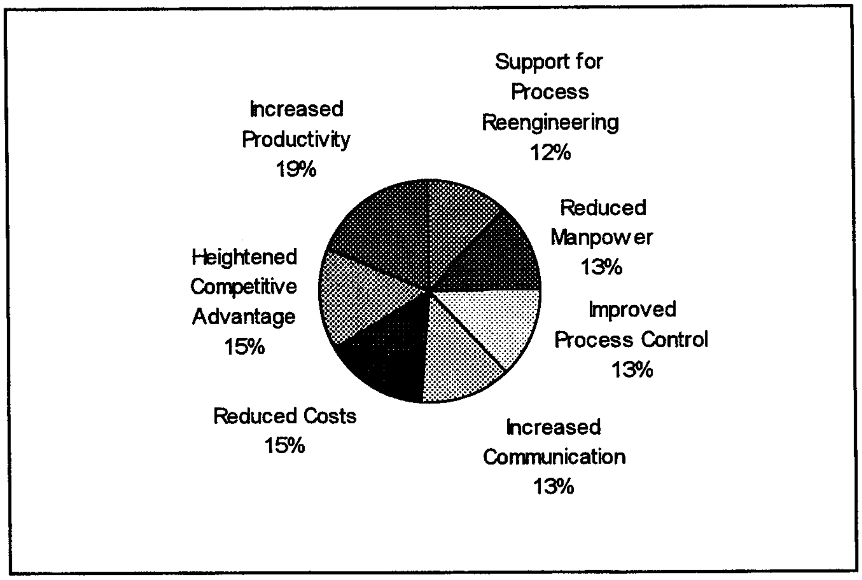

Figure 26. Benefits of Implementing a Workflow System, After Delphi Consulting Group, 1993

1. Increased Productivity

Businesses which install a workflow management tool experience a marked increase in productivity:

> Workflow automation software can help increase productivity significantly, whether as part of a comprehensive business-process reengineering project or used alone. It does so by automatically coordinating the activities involved in general business processes, for example routing documents, monitoring their reception and returning them to the originating manager after coworkers have added their comments. (Burns and Chalstrom, 1993)

> As a result, all members of the organization become aware of the status of its products and services, and can work together to more effectively produce output. Updates to a business process can be made at any position within the organization, at the time of change. This makes them instantaneously responsive to their operating environment. (Koulopoulos, 1995)

Workflow packages also enable the integration of computer systems. "Its primary benefit is joining islands of information, which use discrete tool sets, into enterprise information systems." (Koulopoulos, 1995) Workflow technologies can help businesses by "...unsnarling office work and finally harnessing the untapped horsepower of millions of PCs (personal computers) and thousands of local-area networks" (Winkler, 1994). In this way, workflow management tools also promote the automation of tasks, thereby, increasing product quality, decreasing lost or misplaced projects, and reducing task completion times.

Systems development productivity is also improved due to the ease of developing a workflow model:

> The new breed of workflow toolkits not only targets professional application builders; it caters to nontechnical end users as well. This is achieved through the addition of easy-to-use graphical interfaces, which often involve "push-button" design capability to let a wide range of "developers" (from novices to experienced professionals) build workflow systems quickly with minimal effort. On one hand, this dramatically expands the base of potential customers for these products. On the other, it significantly enhances the productivity of professional developers by shortening development life cycles--particularly in the internal design and coding phases. The concept of rapid prototyping takes on new meaning when working applications can be built in a matter of hours instead of weeks. (Bragen, 1994)

Authorized users as well as sponsors can join in on the development of workflow systems and significantly reduce the time spent waiting for new system implementation. Users can

quickly and easily fix areas where their requirements were overlooked by designers. This can be accomplished on a real-time basis without interrupting the flow of work.

2. Heightened Competitive Advantage

"One of the most pronounced benefits of workflow is the elimination of idle transfer times" (Koulopoulos, 1995). As was mentioned previously, over 90% of the cycle time of a process is due to transfer times. Workflow management tools automatically transfer work and, hence, eliminate physical transfer time. Queue time may still exist, but should decrease substantially due to the use of priority assignments, automated notification and dynamic work distribution.

The shortening of business cycles allows a company to get its products to the market faster than its competitors. In addition to decreasing the time to market, workflow management tools also help to decrease the costs of operating the business as a result of the improved efficiency, control and productivity enjoyed from workflow. Therefore, their products are also at a lower price than other businesses within the industry. This results in increased market share and competitive advantage:

> A few organizations are starting to pull ahead of the pack by applying the technology and discipline of automated workflow. These organizations are radically altering their work environments and, consequently, distinguishing themselves by achieving quantum competitive advantage in their process cycle times, product innovation, and customer responsiveness by double-digit factors...Not unlike the tremendous competitive pressure to invest in factory automation and quality assurance techniques during this century, workflow systems will become a cornerstone of competitive advantage. (Koulopoulos, 1995)

3. Reduced Costs

Workflow management technologies greatly assist businesses in lowering their costs of operation. "A workflow system can speed up business processes, cut down on errors and save hundreds of thousands of dollars over the way you used to do things"

(Babcock, 1994). As previously mentioned, workflow's automated routing feature decreases business cycle time, which reduces the cost of the good or service. As productivity increases within the organization, fewer employees are required to complete each process. As a result, manpower costs are also reduced.

The office of today continues to have an immense reliance on paper when conducting its business. The use of paper consumes a significant portion of corporate revenue:

> According to a study by Gartner Group, a Stamford, Conn., market research firm, paper-based computer output consumes 2 to 4 percent of corporate revenues. Other studies have shown that the cost of printing and distributing a single page of paper costs between 20 and 25 cents. (Simpson, 1993)

"Seven hundred million pages of computer output are generated each day, and 70% of that paper is used for data entry into other computer systems" (Koulopoulos, 1995). As workflow systems are implemented across an organization, the reliance on paper will decrease. "As workflow brings together the splintered applications across the enterprise it will become the conduit that enables us to finally deliver on the promise of a paperless office" (Koulopoulos, 1995).

4. Increased Communications

The connectivity and messaging capabilities of workflow software provide increased communications within a business. Workflow promotes person-to-process communications, allowing access to information regardless of hours of business operation or personnel availability. With workflow, a manager does not have to talk face-to-face with an employee to tell him/her of work assignments or to check on work status. Employees at a lower level of organization can directly communicate and problem solve without having to go up and down a reporting hierarchy. Also, no one in the organization can claim ignorance of how work is to be completed because corporate knowledge and its

component business rules are captured on-line by the workflow tool. (Koulopoulos, 1995)

Employees have instant access to the information that they need to conduct their assigned tasks. They have the ability to electronically ask questions and receive responses without leaving their workstations. They are no longer limited to talking person-to-person, or to receiving filtered information distributed down from their supervisors. Employees can also inform managers of work completion without stopping the process.

5. Improved Process Control

"One of the many benefits of having an automated workflow is the ability to keep track of individual and group processes and generate reports on work in progress and on the data actually being processed" (Bragen, 1994). Workflow improves process control due to its incorporation and maintenance of defined business rules, work audit trails and monitoring capabilities, and the use of metrics and reports. Also, "...workflow automation software actively manages by making decisions about when events are supposed to occur, automatically tracking and recording progress, eliciting human interaction, launching processes and accessing external information" (Creative Networks, 1994). Employee workloads can be analyzed, monitored and balanced. Data integrity and reliability are greatly improved due to their electronic capture and storage. (Koulopoulos, 1995)

6. Reduced Manpower

Improved worker productivity, electronic communications, and the automation of work routing, tracking and completion result in a reduced manpower requirement. The graphical process modeling and on-line reporting features of workflow allow an employer to monitor how jobs relate to each other, how work is conducted, and how employees are performing.

7. Support for Process Reengineering

Davenport states that a reengineering tool should be capable of:

- "...graphically portraying the process steps;
- depicting the flow of materials and information between steps;
- accepting and portraying flow rate, resource and time consumption, and capacity and/or trigger information for each process step;
- rolling up or exploding the steps of the process in a hierarchical fashion to accommodate varying levels of detail;
- presenting a highly interactive and preferably graphical user interface;
- running live simulations and producing real-time graphical output; (and)
- identifying key bottlenecks and constraints in the process..." (Davenport, 1993)

Workflow management technology possesses all of this functionality. It contains an automated process modeling tool with a graphical user interface that enables the decomposition of processes to the level of actual work steps. "Workflow software allows a user to define a process on-line, including the dependencies between tasks and the system functions that are tied to specific tasks" (Petrozzo and Stepper, 1994). The process modeling and documentation capabilities of workflow allow the capture and scrutinization of processes that are too complex to be examined and improved without the use of information technology.

"Another key benefit of workflow automation is that once a business process has been automated, it is easier to incrementally improve" (Creative Networks, 1994). The real-time capture and reporting of process performance metrics such as time, cost and value eliminate the need to maintain external forms or spreadsheets to calculate the value added by the task. They also enable a business to identify areas of the process that require improvement.

Once enhanced processes have been identified, the workflow technology allows the simulation of these process changes prior to execution. The reengineering team is then

able to identify the strengths and weaknesses, such as bottlenecks and high costs, of each proposed improvement. The workflow tool records any changes to the process model and makes corresponding changes to the workflow system. The new process can then enacted by the workflow engine.

The ability of workflow management technology to support BPR has been widely supported in literature:

- "Workflow software takes business problems and translates them into technical solutions that streamline work processes and make them more efficient" (Howard, 1994).
- There is "...increasing interest of organizations using work-flow software as part of a full-fledged reengineering project" (Klein, P., 1993).
- "Although workflow appears to represent only one component of total re-engineering, no reengineering project should proceed without the use of workflow, at the very least as an analytical tool. The reason? How can you undertake a redefinition of an organization if there is no benchmark against which to measure the efficiency of it business processes?" (Koulopoulos, 1995).
- "Workflow, more accurately called work management, turns the abstract themes and expectations of business process reengineering into a practical and concrete method to implement that reengineering" (Howard, 1994).
- "Workflow automation lies at the heart of the trend toward 'process reengineering' as a way of increasing competitive efficiency in today's business climate. To take strategic advantage of automation, businesses must reevaluate and reorganize the way in which information is shared and routed." (Bragen, 1994)
- "Workflow can be used to reengineer business processes completely, not just fixing processes, but quite literally changing the way in which the organization does business" (Howard, 1994).
- "Workflow models, which show the flow of work products from one work unit (e.g. a department or a person) to another, are commonly used to describe business processes and for discussing their redesign. Because of their close correspondence to observable entities and activities, workflow models are intuitive and easy to understand." (Yu and Myopoulos, 1994)
- "Users realize that the full benefit of workflow automation is only realized when this technology is utilized as part of an ongoing life cycle reengineering

process laying the foundation to an organization capable of perpetually modifying its procedures based on real-time assessment of workloads, resources and throughputs." (Delphi Consulting Group, 1993)

- "When implemented to automate existing processes, workflow can establish baseline metrics and long-term monitors for the efficiency of business processes." (Koulopoulos, 1995)

E. OBSTACLES TO WORKFLOW MANAGEMENT AUTOMATION

Delphi Consulting Group found that the most prevalent obstacles to implementing workflow systems were (in descending order) cultural resistance, requirement for reengineering, immature technology, the lack of standards, and high initial cost. Figure 27 shows the ranking of these responses. (Delphi Consulting Group, 1993)

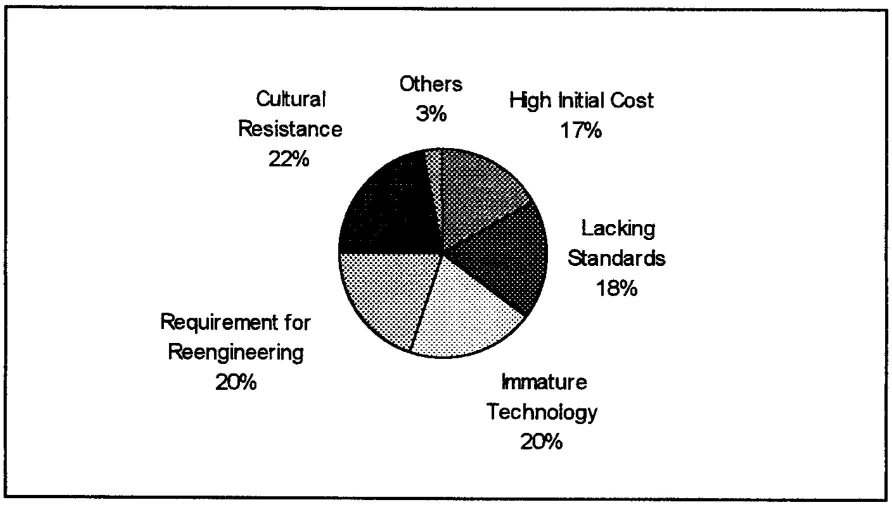

Figure 27. Obstacles to Implementing a Workflow System, After Delphi Consulting Group, 1993

1. Cultural Resistance

"The largest single obstacle faced by organizations planning to implement workflow is that of existing organizational culture" (Koulopoulos, 1995). Employees have many fears and resist any change to the existing corporate structure or procedures.

(Koulopoulos, 1995) Those in positions of power or influence fear that their level of control might be reduced once the information and work of the organization is automated.

Employees also worry that their positions within the company may be abolished due to automation or reengineering of their tasks. Organizations have changed with the advent of information systems and harsh economic times. Many organizations have been forced to downsize their staffs. "The rise of global competition for markets has now made productivity a basic survival issue for most companies, and we have seen in recent years tremendous changes in the way companies are organized to perform office work: leaner organizations, decentralization, flatter management structures," (Silver, 1994).

Workers fear that a change to the organization's structure might mean a new and foreign way of doing business. They are apprehensive that their jobs may be significantly altered, and are unsure and skeptical about the possible success of the new technology. Employees also fear that, with the installation of automated workflow management, they will be inundated with information. They also fear that the breaks they presently enjoy will cease to exist with the abolishment of work transfer times. They believe that they will be constantly tied to their workstations with queues of awaiting tasks. (Koulopoulos, 1995)

"Loopholes and hidden inefficiencies become evident as existing processes are analyzed and eliminated through the development of automated work rules" (Koulopoulos, 1995). The on-line gathering of performance measures and reporting features of workflow expose poor performers and non-value added tasks. Substandard employees, therefore, fear that they will have to work harder than they have in the past.

A stovepipe computer system contains vast amounts of information. Personal power and strategic advantage has been enjoyed by the individual who controlled the system. Employees that have enjoyed this advantage become fearful of losing it:

> Information and its ownership means control and security. Careers and livelihoods are determined by specialization of knowledge and availability of information. Take this away from workers and they lose interest in the product, service, or task at hand. (Koulopoulos, 1995)

2. Requirement for Reengineering

Reengineering takes a lot of time, effort and money to complete. Having invested hundreds of thousands of dollars on the new workflow tool, business leaders may not want to dedicate the personnel or funding required to also reengineer business processes. Also, employees at all levels may not want to participate in reengineering efforts. They are happier left to their own tasks. Reengineering may be viewed as a threat to their job and their level of influence and control.

3. Immature Technology

Because workflow technologies are still in their infancy, some businesses are hesitant to invest hundreds of thousands of dollars in these applications. Many tools on the market do not yet contain comprehensive functionality. "Most noticeably lacking in current generation workflow products is the ability to simulate workflow procedures prior to implementation" (Koulopoulos, 1995).

4. Lacking Standards

Another problem area, identified by users and vendors alike, has been the lack of software standards in the workflow industry:

> Today's software makers, businesses and governments encounter difficulties combining the management of processes when WFM (workflow management) software from multiple vendors are operating in a business. This is due primarily to the lack of specifications that describe how interoperation of that software should occur. ("Work Flow Management....," 1993)

Due the lack of interoperability, companies must chose a single product to support the workflows of the entire organization.

The Workflow Management Coalition (WfMC) was formed in October of 1993 to define standards for terminology, methods, interfaces, integration of applications and

implementation techniques. The goal of the WfMC is to promote the development of workflow products that can interoperate. The coalition is composed of companies and consultants from the workflow industry. ("Work Flow Management....," 1993)

5. High Initial Cost

The cost of implementing a workflow management system is quite high. With information technology budgets decreasing, managers must be extremely careful about their systems investments. Until workflow technology is well proven and the costs fall, many businesses will not choose to purchase a workflow system.

F. WORKFLOW MODEL DESIGN METHODOLOGIES

In the course of this research, numerous books and magazine articles on the topic of workflow management were examined in an attempt to locate methodologies for workflow model design, and, more specifically, workflow design methodologies that incorporate business process reengineering. Although a workflow life cycle was outlined in one publication, only one workflow design methodology was discovered. This methodology, and a demonstration version of its supporting software tools, was secured only after paying over $1,000 in registration fees to attend a two-day seminar hosted by a leader in the workflow consulting industry (Delphi Consulting Group, 1995).

A brief overview of the workflow life cycle and the workflow design methodology follows. Other methodologies exist, but are trademarked and tightly protected by consulting firms and software providers in the workflow industry.

1. Automated Workflow Management Life Cycle

Like other systems development methods, automated workflow management has its own life cycle (Hsu and Howard, 1994). Figure 28 shows the life cycle stages and the interrelationships between them. The term "cycle" conveys that workflow is dynamic, not static. As business processes are adapted to changes in their competitive and volatile environment, so too must be the workflow model that supports them.

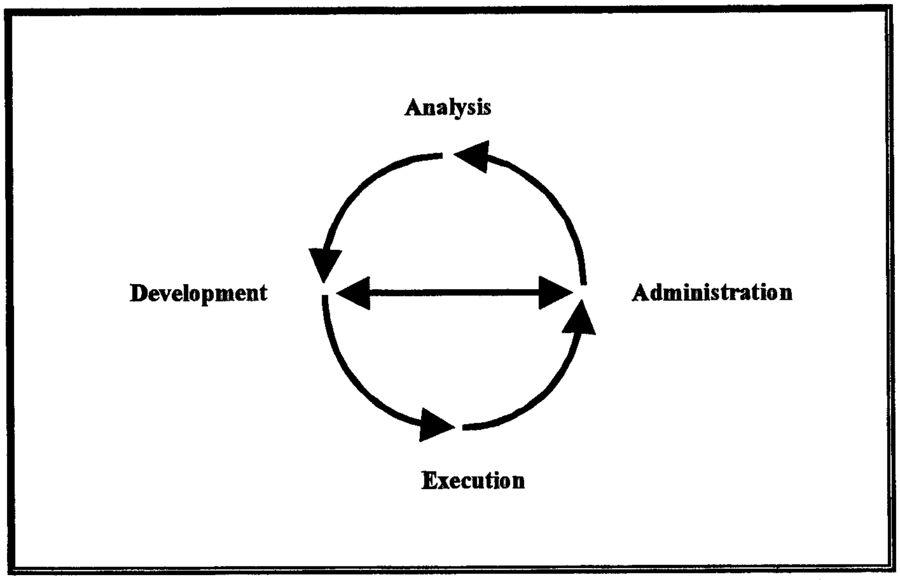

Figure 28. Life Cycle of a Workflow Application, After Hsu and Howard, 1994

The first stage of the life cycle is Analysis. Within this step, the work breakdown structure is produced. The targeted processes are identified, examined and split into tasks. Component rules, resources, roles, routing, cycle time and work objects are identified for each task.

The second stage in the life cycle of workflow management is Development. In this stage, the results of the workflow analysis are used to construct workflow templates. The required supporting data such as personnel, work objects, and resources are entered into the application's database to complete the model. Process templates and their component parts are reused to create similar workflow templates.

Execution of an instance of the workflow template is the third phase. Automated routing occurs as employees complete their assigned tasks. Process metrics such as completion time, consumed resources and costs are catalogued and reported.

The fourth phase in the workflow life cycle is Administration. During this stage, changes to the workflow templates are made based upon feedback from the execution or development stages. The workflow infrastructure is also maintained and updated as required to support changes to the process.

2. Delphi Workflow Method™

The Delphi Workflow Method™ is a workflow design methodology trademarked by Delphi Consulting Group. This methodology includes three phases and uses two independent software tools. (Delphi Consulting Group, 1995)

a. Phase I: Defining the Existing Business Processes and Technology Infrastructure

During the first phase of the Delphi Workflow Method™, the scope of the project is determined. Delphi Consulting Group recommends that the initial project be small so that it can be completed quickly and successfully. They advocate selecting a process that includes fewer than 50 participants. This will assist in gaining "buy in" on the part of the company's employees and will help the company keep up with the pace of changing information technology.

Once the scope of the project is determined, a project sponsor is identified. This person should have control over the workflow to be implemented. The sponsor should also have the budget resources necessary to support the initial workflow effort.

Next, the processes to be implemented on the automated workflow management system are identified. The participants of each task are determined as well as the logical flow of information between each task. This information, as well as user requirements, is gathered within a two week period via interviews with users, information technology personnel and process sponsors. The information gathered is not complete. Future interviews are conducted to refine the data.

The workflows are modeled using Delphi's graphical tool, the Workflow Factory™. The result is a graphical depiction of the business process, which Delphi calls the System Schematic™:

> The System Schematic™ is the foundation of a well designed workflow application. It will be used throughout the entire analysis and design process to assist in understanding how information flows through the organization, how it is processed and accessed, and how the proposed

workflow environment will be supported by the existing or planned hardware, software, and communications infrastructure. (Koulopolous, 1995)

An example of a System Schematic™ is provided in Figure 29.

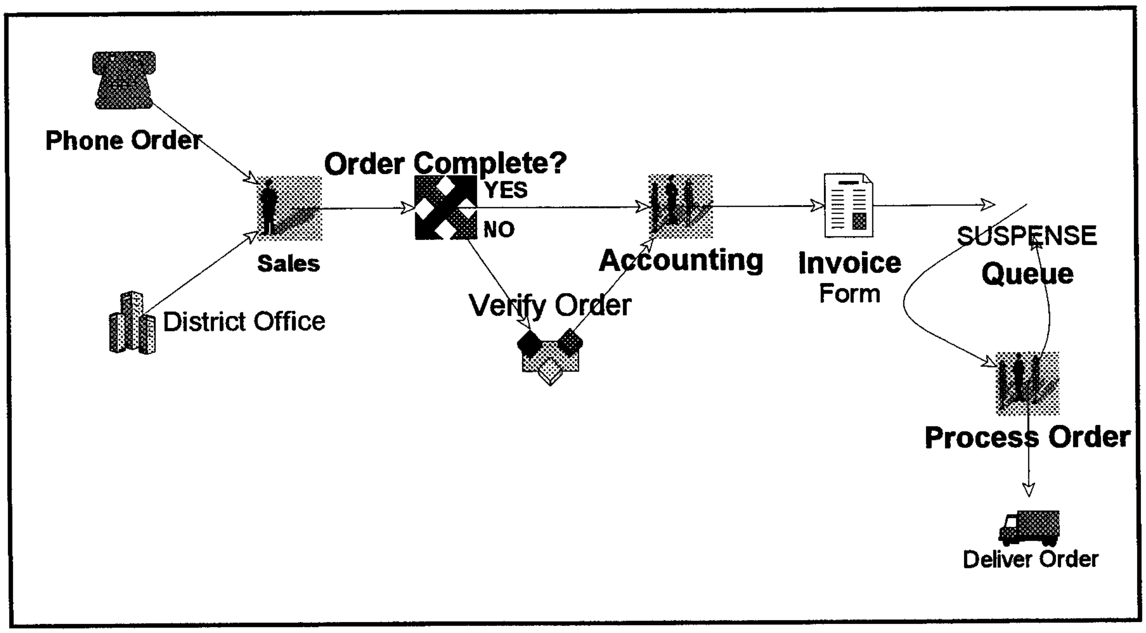

Figure 29. Example of a System Schematic™, From *Workflow Factory*™, 1995

Once the process has been modeled, the infrastructure that will support the workflow is determined. This includes hardware, networks and software applications that will be a part of the workflow management system.

Next, the System Schematic™ is finalized. A group of approximately 25 people is gathered together to discuss the boilerplate version of the schematic. This group includes users, information technology personnel and project sponsors. Within two or three days of discussion, a final version of the schematic is designed.

b. Phase II: Selecting the Initial Application

Delphi promotes implementing a workflow solution in small steps:

> The Stair Step Method begins with a broad view of the problem and the solution. However, solutions are implemented one step at a time. A *step* is a process, within a sponsor's organization, that is defined well enough so that it can be implemented quickly and easily. The principle benefit of a step implementation is that it provides quick increments of change. (Koulopolous, 1995)

First, each activity (process) is listed as a row heading in a two-dimensional matrix. This is automated in a Microsoft© Excel spreadsheet. Next, workcells, which are the personnel responsible for completing each process, are defined. Each workcell is listed as a column heading across the matrix. Two copies of the Stair Step™ matrix are prepared.

The group of corporate personnel is reassembled and they place a number in the matrix cells where each task and workcell intersect. On one sheet, this number represents the count of people involved in the process; on the second sheet, the number of work objects. The rows and columns of each matrix are then totaled. These totals reflect the relative complexity of each process and the workload of each workcell. The process chosen for implementation is the one that is either the most or least complex. "If you average these totals across applications, your ideal pilot will almost always be found within one standard deviation of this average for both Stair Step models (document- and people-based)" (Koulopoulos, 1995).

c. Phase III: Identifying the Areas of Business Cycle Weakness and Inefficiency

The next step in Delphi's methodology is to complete a Time-Based Workflow Analysis™. This involves completing another Microsoft© Excel spreadsheet. In this worksheet, the process is broken down into tasks and each task becomes a row heading. Work cells are again listed across the columns of the matrix. Additional columns

are added for task completion and transfer times. "By evaluating the relationship of transfer time to task time we can begin to formulate opinions as to likely workflow candidates for streamlined business processes" (Koulopolous, 1995).

Overall task completion and transfer times are listed for each task. Then, these times are apportioned to each workcell within that task. In the time analysis matrix, the transfer time for a task is assigned to both the sending and receiving work cells. This is done because Delphi feels that no one is accountable for transfer time:

> Because TBA is based on the premise that 90% of the business process problem lies in the process itself, and not in the tasks performed by the people, it minimizes the perceived threat of the workers themselves being identified as the problem...transfer time belongs to no one. No one takes responsibility for it and no on is to blame." (Koulopolous, 1995)

The time values in each cell of the matrix are then analyzed. The cells with the highest task or transfer times are possibly overworked and may be the cause of process bottlenecks. Task completion and transfer times are compared:

> In many cases, simply eliminating the transfer time can substantially improve a business cycle. Add to this the ability to track the document and spontaneously interact with individuals throughout the workflow process, and workflow may change the total cycle time without changing a single task, but rather by collapsing the idle time between tasks. (Koulopolous, 1995)

3. Analysis of Workflow Methodologies

The workflow life cycle that Hsu and Howard (1994) illustrate is not complete. It contains no information on the preparation phase or project sponsorship. It also does not address business process reengineering.

Delphi's workflow methodology is also not comprehensive. It does not address workflow implementation or maintenance. The procedure is quite complex and the

concepts behind its Stair Step™ method are difficult to comprehend. Although the methodology is supported by automated tools, it requires two separate software tools for its support, none of which provides executable workflows or on-line gathering of process metrics.

Delphi's methodology does include a consideration of process improvement. However, it addresses only one reengineering principle, focusing entirely on decreasing the cycle time of a process. Delphi's president states: "The objective of workflow analysis is to redefine and then reconstruct the components of lengthy business cycles in such a way that the time required to execute a task is minimized and the transfer time between tasks is eliminated entirely." (Koulopolous, 1995) Other opportunities for reengineering such as capturing information only once, reducing checks and controls on work, providing a single point of contact, or letting workers make decisions are not considered. Also, the queue time of a task is not separated from transfer time or analyzed.

No satisfactory methodology was found in literature for workflow design that includes BPR and uses a single workflow tool to support all of its steps.

> Because workflow is as much a discipline as it is a technology, you would expect workflow vendors to provide a methodology for business process redesign and simulation, not a technology alone. In all but a few cases you would be mistaken. Objective workflow methods are not prevalent. (Koulopolous, 1995)

The next chapter delineates a workflow design methodology proposed by the author. The methodology was conceptualized using the BPR and workflow methodologies previously described, as well as original ideas. This method incorporates BPR through the use of a single, comprehensive workflow management tool. "Methodologies that use software tools to model and analyze the workflow, simulate performance to identify bottlenecks, and tie into workflow application development are especially welcome by users" (Silver, 1994).

V. WORKFLOW REENGINEERING METHODOLOGY

"A successful organizational change and business process redesign initiative requires the use of a formalized methodology as a road map" (Yu, 1994). After an extensive and unfruitful search for a detailed methodology for workflow design and, more specifically, one that included business process reengineering (BPR), the Workflow Reengineering Methodology is proposed. This chapter includes an overview of this methodology. Figure 30 lists the five phases and 32 component steps of the Workflow Reengineering Methodology.

The proposed methodology should be tailored to the organization in which it is to be used. For example, if the business already has a process improvement program in place, many of the initial steps of Phase I will be unnecessary. If automated workflow has already been instituted within the organization, the completion of Phase II may not be required. The methodology must also be fitted to the functionality of the particular workflow management tool installed within the organization.

A copy of all the forms described within this chapter are provided in Appendix A. These forms can be used to collect and record process data if the workflow tool cannot be used, or is not available, for direct entry.

A. PREPARE FOR WORKFLOW INNOVATION

During the first phase of Workflow Reengineering, there is a recognition of a need for improvement in the way business operations are conducted. Command sponsorship is obtained for a reengineering project enabled by automated workflow management technology. Change leadership structures are established, and a reengineering team is assembled and educated to support the change effort. An automated workflow management tool is obtained and installed. The business cycles of the organization are identified and a vision for the organization's future is established. The project environment is defined and a business cycle is selected for improvement. A proactive

PHASE I: PREPARE FOR WORKFLOW INNOVATION

Step 1: Identify a Need for Process Improvement
Step 2: Gain Management Sponsorship
Step 3: Establish Change Leadership Roles
Step 4: Introduce Automated Workflow Management Technology
Step 5: Build, Educate and Train a Change Team
Step 6: Identify Business Cycles
Step 7: Create an Organizational Vision
Step 8: Analyze the Project Environment
Step 9: Implement a Change Management Program

PHASE II: AUTOMATE EXISTING WORKFLOW

Step 1: Catalog Business Products
Step 2: Identify Business Processes
Step 3: Select a Process for Implementation and Improvement
Step 4: Construct a Work Breakdown Structure
Step 5: Define Task Components
Step 6: Specify Performance Measures
Step 7: Complete and Verify the Workflow Model
Step 8: Install and Test Required Infrastructure
Step 9: Implement and Monitor Automated Workflow

PHASE III: IDENTIFY PROCESS IMPROVEMENTS

Step 1: Consider the Customers' Requirements
Step 2: Benchmark Against Industry Leaders
Step 3: Specify Performance Goals
Step 4: Reengineer the Workflow
Step 5: Construct New Workflow Models
Step 6: Simulate Each Workflow Alternative
Step 7: Select the Most Efficient and Effective Workflow

PHASE IV: ESTABLISH SUPPORTING STRUCTURES

Step 1: Identify Organizational Changes
Step 2: Specify the Required Infrastructure
Step 3: Gain Approval
Step 4: Institute Organizational and Infrastructure Changes

PHASE V: IMPLEMENT AND MAINTAIN IMPROVED WORKFLOW

Step 1: Implement the New Workflow
Step 2: Manage the Workflow Configuration
Step 3: Perform Continuous Improvement

Figure 30. Workflow Reengineering Methodology

change management program is then employed to prepare all employees for modifications to business operations, and to train them on how to operate the workflow management tool.

1. Identify a Need for Process Improvement

Before innovation can begin within an organization, there must be an identifiable need for improvement. Someone must be dissatisfied with the present system of operations. This discontentment might be expressed by an employee, manager, business owner, regulatory agency or customer. There are many possible drivers for the dissatisfaction. "Improved financial performance, customer satisfaction, and operational efficiency, reliability, and agility are often key internal motivators for a change program" (Yu, 1994). Once a need for process improvement has been identified, the change requirement must be documented and its justification brought to the attention of senior management.

2. Gain Management Sponsorship

Executive level management support must be acquired for the change effort if it is to be successful. Senior managers have a more broad and complete picture of the operations of the business. They understand and can predict the effect of a process change on the overall business practices of the company. They possess the authority necessary to approve changes that affect multiple departments, and the control required to overcome any controversies or obstacles. Also, they manage the organization's budget and determine if a change effort will receive adequate funding. (Hammer and Champy, 1993)

To assist in obtaining sponsorship, seek a well respected and influential leader within the organization who possesses a vision for improvement. If the organization has a change leader designated, approach this person. Solicit his/her assistance in promoting and presenting the change initiative, and the use of an automated workflow management tool as the enabler of this change, to senior management.

Request that a meeting of the executive leadership of the organization be called. At this meeting, present the need for improving business processes. Be sure to include supporting cost figures and improvement statistics, as well as an overview of the concepts and principles of reengineering presented in Chapter II. Tie the need for improvement to the overall success of the business in terms of productivity, cost and market share. Also, use the supporting information provided in Chapter IV to explain the functionality and benefits of an automated workflow management tool. Be sure to emphasize how the workflow tool can be used to support reengineering efforts. (Harrington, 1991)

3. Establish Change Leadership Roles

During the meeting with senior management, request that an executive-level reengineering steering committee be established and that personnel be assigned as the reengineering leader and the reengineering czar. Refer back to Chapter II for the responsibilities and characteristics of these leaders.

4. Introduce Automated Workflow Management Technology

Request that a workflow management tool be procured and installed within the organization to automate and improve business practices. Upon receiving approval, consult with your Information Technology (IT) Manager and with software companies from the workflow industry to determine which type of workflow package would best meet the needs of your organization. Refer to Creative Networks, 1994, for a list of workflow vendors and product specifications. Select and purchase a workflow management tool with comprehensive functionality. Have the IT Manager identify, obtain and install the supporting infrastructure required to provide organization-wide connectivity.

5. Build, Educate and Train a Change Team

Once management's support for the change effort has been secured and the key leadership positions have been established, construct a change team of five to ten

employees to conduct workflow modeling and improvement. The composition of the team is critical to the success of the project. It should include employees from several functional specialties, including the information technology division.

> At a minimum, the team should include both people who are familiar with the target process(es) and people who are unfamiliar. The role of the former is to bring knowledge of the way things are done today. The role of the latter is to bring the creative naiveté to ask, "Why do we do things this way?" (Klein, M., 1993)

There are several criteria to consider when evaluating employees for group membership. The employees should possess high degrees of business knowledge and be proponents of ongoing learning. They should be action oriented, well respected, forward thinking and unafraid of taking risks. They should be strong problem solvers with proven analytical and teamwork skills. Also, they should possess positive attitudes toward the project and be voluntarily participants. (Yu, 1994)

After the team members have been selected, assign them to the project with official letters of designation signed by the head of the organization. If possible, appoint the team members to the reengineering effort on a full-time basis. Because process analysis and redesign is time consuming and must be completed within a limited amount of time, a minimum of 75% commitment level is required for project success (Hammer and Champy, 1993). This level of commitment by management will not only allow the project to be completed more promptly, it will also signal to employees that the project is of great importance to the company.

Set up an initial team meeting. Then, secure a comfortable work setting for the team that is equipped with computer terminals and the workflow management tool installed to be used during the workflow reengineering process. Once the team has been assembled, brief them on what the project is about, who will be involved, and what to expect.

> Team members must be trained in the techniques that will be used in the course of the innovation effort. These include problem solving, process documentation, and group dynamics. Training can also reduce the time it takes for team members to begin to feel comfortable working together. (Davenport, 1993)

Educate the team on the principles of change management, workflow modeling, business process reengineering, and the Workflow Reengineering Methodology. Provide training on the functionality and use of the workflow management tool to be used within the organization. Include a demonstration of the workflow software tool, using an example scenario so that they can see how the program works and what information is required to construct a workflow model. Be sure to allow adequate time for each member to independently manipulate and become familiar with the workflow tool.

6. Identify Business Cycles

Once the change team has been trained, identify and record the business cycles of the organization. A business cycle is an overall objective of an organization. It represents one of the company's purposes for existence, at its highest level of abstraction. For example, the business cycles of a bank might include *Acquiring Money*, *Investing Money*, *Lending Money* and *Managing Accounts*.

To determine the organization's business cycles, identify the mission and goals of the establishment by gathering and reviewing any regulations or directives that govern the company's operations. Also, answer the questions of "What do we do?" and "Why do we do what we do?" Compare the stated mission to the answers given and note any inconsistencies. Next, consult with the executive-level steering committee for clarification and validation of the business objectives to ensure that the identified roles of the organization are comprehensive and correct.

Record these verified business cycles on a copy of the Organizational Information Form, provided in Appendix A as Figure A-1. Also, enter the following data into the worksheet: Organization Name, Location(s), and Hours of Operation.

7. Create an Organizational Vision

To improve, an organization must possess a vision for what it desires to become in the future. To define an organizational vision, meet with the business' owner(s) and the executive steering committee. Ask them to specify their goals for the future of the organization. They should take into consideration what other businesses in the industry are doing and what your business needs to accomplish to remain competitive.

Ask the steering committee to describe the business strategy to be undertaken to achieve their stated objectives. Davenport specifies several criteria to be used when developing or analyzing a corporate strategy. A strategy should (Davenport, 1993):

- Be partially non-financial;
- Possess measurable components;
- Be distinctive to the industry and company;
- Be inspirational;
- Be long-term, at least five to ten years, in focus; and
- Address tools for change.

Ensure that the owner(s), reengineering steering committee and all members of the change team understand the objectives of the corporation and the strategy to be undertaken to achieve them. Assess and include a statement of senior management's position on the use of personnel retraining, reassignment and/or downsizing to achieve its business goals. The Workflow Reengineering Methodology and the supporting workflow management tool should also be a stated part of this strategy.

The reengineering czar should then publish a business process improvement directive (Harrington, 1991). This directive should communicate the purpose and principles of reengineering, the need for process improvement, the reengineering approach to be undertaken and the responsibilities of all employees in the improvement effort. It

should also contain a vision statement that articulates two key messages to the organization:

> The first of these is: Here is where we are as a company and this is why we can't stay here. The second is: This is what we as a company need to become. (Hammer and Champy, 1993)

Figure 31 is an example of a vision statement of a pharmaceutical company provided by Hammer and Champy (1993).

VISION **PHARMACEUTICAL COMPANY**
• We are a worldwide leader in drug development. – We have shortened drug development and registration by an average of six months. – We are an acknowledged leader in the quality of registration submissions. – We have maximized the profit potential of our development portfolio. • We have created, across our operating companies, a worldwide R&D organization with management structures and systems that let us mobilize our collective development resources responsively and flexibly. – We have established uniform and more disciplined drug development planning, decision-making, and operational processes across all sites. – We employ innovative technology-based tools to support our work and management practices at all levels and between all R&D sites. – We have developed and implemented a common information technology architecture worldwide.

Figure 31. Example of a Vision Statement, After Hammer and Champy, 1993

8. Analyze the Project Environment

Prior to beginning the change effort, it is critical that the project team identify and understand the conditions under which they must operate. The present environment holds numerous change leverages and obstacles that must be clearly identified in order to be utilized or overcome during the reengineering project. (Davenport, 1993)

a. Inventory Organizational Resources

The efficient use of organizational resources will be analyzed during the reengineering initiative. Therefore, the change team must have an accurate and detailed list of available assets. These resources include personnel, information systems infrastructure, facilities (including utilities), and materials.

Submit a copy of the Organizational Personnel Form, provided in Appendix A as Figure A-2, to the organization's human resources office. Have them complete a form for each unit of the organization. The information to be listed on this page includes the unit name and location; the titles, basic and overtime pay rates with benefits included; the working hours of each position within that unit; and the number of employees that hold identical titles and pay rates. The names of the personnel filling the positions are not required but may be entered into the workflow tool for cross reference.

Ask the human resources office for an organizational structure chart. The structure of the organization will illustrate to the change team how communications and control presently flow within the company. If there is a published chart, ensure that it is comprehensive and current by asking each department head to verify their portion of the diagram. If there is no existing structure chart, request that each department head and unit manager provide a sketch of their organizational unit. Depict the company's structure down to the lowest level of employment, labeling entities with their position titles. Then, combine these separate charts into an overall corporate structure diagram. Also, identify to whom your organization reports and sketch the external chain of command.

Next, determine the existing information systems infrastructure of the company. The information systems that are presently operated within the organization are important to the change effort and, therefore, must be identified and understood by the change team:

> Just as information technology can provide exciting opportunities for process innovation, it can also impose considerable constraints on process designs. It is easy to suggest that firms ignore existing systems and

> technology infrastructures in designing a new process, but it is seldom realistic to do so. Existing systems are often too expensive, complex, and embedded in an organization to simply assume them away. Instead of pretending to have a clean slate, firms should acknowledge the constraints existing systems impose on a new process, understand their implications, and make the best of them. (Davenport, 1993)

Request a copy of the business' infrastructure diagram from the IT Manager. This diagram should include a depiction of all the organization's computer hardware, software and communications assets and their connectivity. Figure 32 is a simplified example of an infrastructure diagram. Have the IT Manager present a briefing

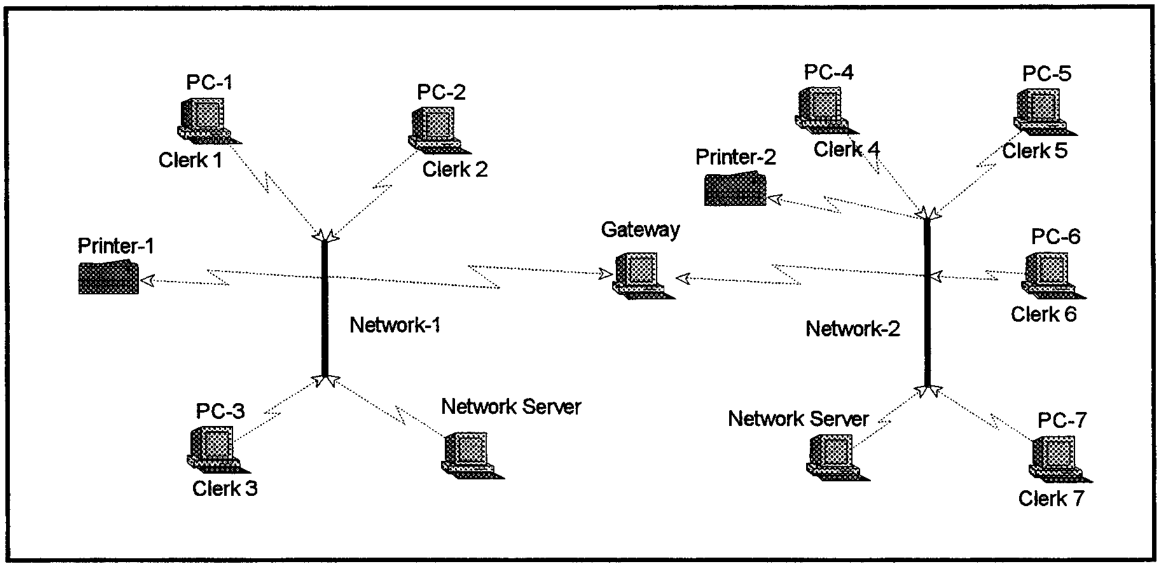

Figure 32. Simplified Infrastructure Diagram

on the infrastructure to the reengineering team, identifying those areas within the identified business cycles where there is no workflow system coverage and the reasons for the lack of connectivity. Also ask the IT Manager to complete a copy of the Organizational Resources Form, provided in Appendix A as Figure A-3. The information to be listed on the form includes the resource name, type, quantity, unit cost per unit or hour of operation, and the hours of availability.

Submit a copy of the Organizational Resources Form to the organization's plant property and supply managers for a detailed listing of facility and material unit costs and availability. If your organization does not have unit costing in place, this must be established by your company's financial manager.

b. Delineate Project Funding

Reengineering efforts require the expenditure of great amounts of money for personnel, research, and infrastructure. The amount of funding allocated to a reengineering project can limit the scope of the undertaking. Determine the funding level that has been allocated to the present project. If the amount seems unreasonably small, approach the reengineering leader, with the aid of the reengineering czar, and request additional funding. Explain to the leader that the lack of resources will severely limit the actions of the reengineering team. "Assigning skimpy resources to the reengineering effort also signals the organization that management doesn't consider the attempt to be terribly important and encourages people to ignore or resist it in the expectation that before long it will have run its course and gone away" (Hammer and Champy, 1993). A representative of Andersen Consulting "...suggests that the entire BPR program typically costs 1% to 2% of sales...depending on the size and scope of the company" (Rock and Yu, 1994).

c. Determine Project Scope and Time Frame

Normally, a company does not possess the resources required to reengineer all of its business cycles at one time, nor can it absorb the risk inherent in a corporate wide project. Selecting too broad of a scope for the initial project might overwhelm the change team:

> Reengineering requires sharp focus and enormous discipline, which is another way of saying that companies must concentrate their reengineering efforts on a small number of processes at any given time. An

> organization becomes bewildered rather than energized when it's asked to do too much at once. (Hammer and Champy, 1993)

Therefore, the scope of the project must be limited. It is recommended, and this methodology is built on the premise that only one process at a time within a single business cycle be implemented on the automated workflow system and analyzed for improvement during the project. "Experience has shown that an incremental approach, evolving from a quick pilot application to embrace a gradually increasing number of users and reengineered process functions, has a greater chance of success" (Silver, 1994). Keeping the scope narrow, allows the reengineering team to learn the methodology and master the workflow tools. It also provides a track record of workflow reengineering success.

With the assistance of the executive steering committee, select the business cycle that is most in need of improvement. This will probably be the area with which there was an expressed dissatisfaction. Later in the methodology, when the team becomes more familiar with the processes that make up the business cycle, they will limit the scope of the project down to a single business process. Next, on the Organizational Information Form, rank each of the remaining business cycles in the order that they will be considered for future improvement projects.

Once the scope of the project has been agreed upon, specify the time frame to be allotted to the project, as well as target milestones. Ensure that the time frame is reasonable for project completion. Hammer and Champy suggest that any reengineering project should be completed within twelve months:

> Our experience suggests that twelve months should be long enough for a company to move from articulation of a case for action to the first field release of a reengineered process. Take longer, and people will become impatient, confused, and distracted. (Hammer and Champy)

The time frame should not vary significantly from this original estimate. Employees will be closely watching the progress of the project and their resistance to change will build the longer the project continues. (Hammer and Champy, 1993)

9. Implement a Change Management Program

"Successful implementation of process innovation depends on consciously managing behavioral as well as structural change, with both a sensitivity to employee attitudes and perceptions and a tough-minded concern for results" (Davenport, 1993). Be aware that resistance to change is a normal reaction on the part of employees:

> Managers know that any kind of change -- new ideas, new methods, new programs, new technologies -- stirs resistance. If it is allowed to build, this resistance soon forms a strong wall protecting the status quo. (Terez, 1993)

To control any employee resistance throughout the course of the workflow reengineering project, implement a proactive change management approach. Follow the nine change management guidelines specified by Tom Terez, a consultant for Modern Management Incorporated (Terez, 1993). These guidelines are presented in Figure 33.

> This kind of proactive approach will enable management to deal with the sources of resistance before they have time to surface and build. It will also help convince employees that nothing is being hidden up management's sleeve. (Terez, 1993)

First, analyze the operations of the business to gain an understanding of what and with whom you are dealing. Understanding the operational environment requires an analysis of job predictability, employee unity, and isolation. If workers have been accustomed to a particular way of doing business and are happy with the status quo, they will be more resistant to change. If the workers are unionized or will independently unite

Preparing for Implementation

1. Understand precisely what and with whom you are dealing.

Essential Change Management Strategies

2. Take the mystery out of the change by telling and showing employees just what it entails.
3. Motivate employees to commit themselves to the change.
4. Present the change in the form of a challenge, complete with tangible rewards linked to successful implementation.
5. Take steps to ensure that all managers are committed to the same change management game plan.
6. Demonstrate how the change preserves or enhances the state of fairness for employees.

Other Essentials

7. Avoid letting the change get bogged down in excessive employee involvement. Determine and secure the optimal level.
8. Draw up an implementation schedule with specific milestones, and review this timetable frequently.
9. Realize that change is a process of movement and that things will keep moving even after implementation is deemed completed.

Figure 33. Nine Change Management Guidelines, After Terez, 1993

to resist the change, a plan must be created to deal with this. If the affected employees are isolated from the rest of the organization, improved communications must be established to include them in the change management process.

Take the mystery out of the workflow reengineering initiative by briefing the employees on the purpose of the project. Ensure each employee hears and understands the organizational vision statement. Keep the employees informed on the progress of the project and answer their questions about why change is necessary, what changes are being considered, and what affect the changes may have on their jobs. Provide educational sessions about business process reengineering and workflow management principles so that these topics will no longer be foreign or as threatening. Also, provide before-the-fact hands-on training sessions to familiarize all employees with the automated workflow management tool and any new work procedures to be implemented thereon.

Try to motivate the employees so that they will become committed to change in business procedures. There are many incentives that can be used to accomplish this: guarantee of job security, monetary rewards and the promise of simplified duties. Present the idea of change as a challenge. Link tangible rewards to the successful implementation of the automated workflow system.

Show the employees how the new system can maintain or improve the state of fairness to them. "If change managers skirt the issue of fairness, employees will immediately wonder how the change tips the scale of fairness to their disadvantage" (Terez, 1993). Employees must be convinced that the new technology or process can be used to their advantage, and not just in management's favor.

"Among the many ways to build commitment, one of the most effective is employee involvement" (Terez, 1993). Provide an open forum for employee suggestions, but keep employee participation at a moderate level. Although involvement is crucial in gaining employee ownership of the change, too many inputs can overload the process.

Ensure that all management personnel have the same change management plan. "At the very least, managers at all levels must understand the change" (Terez, 1993). They should also publicly voice their support for the use of automated workflow management and the reengineering of business processes. This will demonstrate to employees that the leadership of the organization is committed to change. Also, ensure the plan includes an up-to-date schedule of milestones for the implementation of the workflow system and improved processes.

Finally, realize that even after the new workflow system has been fully implemented, the supported processes will continue to be altered. "In the wake of major change, some employees will slowly revert to the old ways of doing business" (Terez, 1993). Be aware of this fact and monitor employees' use of the new system and procedures.

Continue the proactive change management program during each phase of the Workflow Reengineering Methodology. Brief the employees on what each phase entails

and any possible results. As each phase is completed, publicize the outcome and conduct any required preparatory training.

B. AUTOMATE EXISTING WORKFLOW

During the second phase of the Workflow Reengineering Methodology, the business products of the business cycle under review are identified. The component processes of the cycle are distinguished, and a single process is selected for improvement. The present workflow of this process is modeled and implemented on the automated workflow management tool. The specified performance measures of the workflow are then monitored and recorded for use in the process improvement phase of the methodology.

1. Catalog Business Products

To define the existing workflows of a business cycle, identify the products that result from the completion of that particular cycle. For each business cycle identified in Phase I, make a copy of the Business Process Identification Form provided in Appendix A as Figure A-4. From your production or sales department, obtain a list of the types of goods and/or services that your company produces, their unit costs, and their average market values. Assign each product to the sheet of paper containing the business cycle wherein that product is created. Record the product's cost, value and whether the form of each product is physical or electronic. Figure 34 is a Business Process Identification Form that demonstrates the completion of these steps.

2. Identify Business Processes

Decompose the business cycle into its component processes by identifying how each business cycle product is created. Record the process' name in the product's row on the Business Process Identification Form. Only one process should be specified for each

BUSINESS PROCESS IDENTIFICATION FORM for Business Cycle Lending Money							
Product:	**Form**	**Cost**	**Value**	**Business Process**	**Freq.**	**Priority**	**Condition**
Mortgage Loan	Physical	$100,000	$130,000				
Vehicle Loan	Physical	$ 20,000	$ 21,500				
Consumer Loan	Physical	$ 50,000	$ 52,000				
Credit Card	Electronic	$ 5,000	$ 5,950				

Figure 34. Example of Product Identification

product. If you find more than one process that produces the same output, you may actually be identifying sub-processes. In that case, devise a new name for the higher level process. Delineate how often each process is conducted during an average work week and the priority assigned to the process: low, routine, high, urgent. The priority of the process will be used by the workflow tool to determine work assignment and precedence. Figure 35 demonstrates each of these entries.

BUSINESS PROCESS IDENTIFICATION FORM for Business Cycle Lending Money							
Product:	**Form**	**Cost**	**Value**	**Business Process**	**Freq.**	**Priority**	**Condition**
Mortgage Loan	Physical	$100,000	$130,000	Process Mortgage	50	High	
Vehicle Loan	Physical	$ 20,000	$ 21,500	Process Vehicle Ln.	70	Routine	
Consumer Loan	Physical	$ 50,000	$ 52,000	Process Consmr. Ln	30	Routine	
Credit Card	Electronic	$ 5,000	$ 5,950	Issue Credit Card	100	High	

Figure 35. Example of Process Identification

3. Select a Process for Implementation and Improvement

Once all of the processes within the business cycle have been identified and recorded, refine the scope of the project to include only the workflow of a single business process. To do this, determine the condition of each process by following the Weighted Selection Approach prescribed by Harrington (Harrington, 1991). Using the Process Condition Worksheet provided in Appendix A as Figure A-5, rate each process on a scale of one to five on the factors of changeability, performance, and business and customer impact. Determine the value for each element by answering the following questions:

- **Changeability:** How easily can the process be fixed? (1 = Can not be changed; 5 = Easily changed)
- **Performance:** How does the process presently function? (1 = Well; 5 = Badly)
- **Business Impact:** How important is the process and its product to the success of the company? (1 = Unimportant; 5 = Critical)
- **Customer Impact:** To what extent is the customer concerned with or affected by the present state of the process or its product? (1 = Unconcerned; 5 = Highly concerned)

Record these ratings on the worksheet and total the values across each process as exemplified in Figure 36.

Process Name	Changeability	Performance	Business Impact	Customer Impact	Total
Process Mortgage	5	4	5	5	19
Process Vehicle Loan	4	2	4	5	15
Process Consumer Ln	3	1	5	5	14
Issue Credit Card	1	2	3	4	10

Figure 36. Completed Process Condition Worksheet, After Harrington, 1991

The process with the highest total score is the process that is in the greatest need of improvement. Therefore, select this process for your project. On the Business Process Identification Form, record the ranking of each process in order of their reengineering priority as shown in Figure 37. Use these rankings to program the remaining processes for future improvement projects. These processes will be automated and reengineered prior to moving on to the next business cycle identified on the Organizational Information Form. (Harrington, 1991)

BUSINESS PROCESS IDENTIFICATION FORM for Business Cycle Lending Money							
Product:	**Form**	**Cost**	**Value**	**Business Process**	**Freq.**	**Priority**	**Condition**
Mortgage Loan	Physical	$100,000	$130,000	Process Mortgage	50	High	1
Vehicle Loan	Physical	$ 20,000	$ 21,500	Process Vehicle Ln.	70	Routine	2
Consumer Loan	Physical	$ 50,000	$ 52,000	Process Consmr. Ln.	30	Routine	3
Credit Card	Electronic	$ 5,000	$ 5,950	Issue Credit Card	100	High	4

Figure 37. Example of Process Condition Rankings

Once a process has been selected for implementation and improvement, request that the executive steering committee identify an owner for the process. The process owner will be the senior manager responsible for the effective and efficient functioning of that particular process. He/She should understand the tasks involved in the entire process and be able to predict how any proposed changes might affect both the process and the overall business cycle. (Hammer and Champy, 1993)

4. Construct a Work Breakdown Structure

As explained and shown in Chapter IV, a work breakdown structure is a graphical depiction of the hierarchical structure of a business cycle decomposed into its component parts. The goal of this decomposition is to represent the work of an organization in pieces that can more easily be understood and modeled by the change team.

Use the workflow management package's diagramming tool to construct the work breakdown structure. Draw the tool's applicable figure to represent the business cycle under review. Below the business cycle, enter a figure to represent each of the processes listed on that business cycle's Business Process Identification Form. Next, with the help of the process owner, decompose the process selected for reengineering into its component sub-processes. Then, break each sub-process into its fundamental tasks. These tasks are the actual work steps of the process and should be drawn in the order of their completion. Refer back to Chapter IV to view an example of a work breakdown structure.

5. Define Task Components

As discussed in the previous chapter, a task contains several components: roles, work objects, rules, resources, routing and time. Information about each of these components must be identified and captured for each task. Detailed data on the participants, work objects, rules, types of resources used and work object routing are required to establish the automatable workflow model, and they, therefore, must be collected in advance. The time component and the amount of resources consumed during the task will be measured and recorded by the workflow tool once the workflow has been automated. These components are the direct determinants of process cost and, hence, more precise values will greatly improve the quality of the improvement analysis.

Enter the collected data directly into the workflow tool as it is gathered, or use a Task Definition Form to record the collected data prior to entry into the workflow system. Because the categories of information are sometimes difficult to distinguish, the form may

prove more useful in an initial workflow reengineering project. Use a copy of the form, provided in Appendix A as Figures A-6 through A-9, for each task in the process.

The first step in collecting task data is to identify the employee who performs the task. Ask the process owner to identify the organizational unit wherein each task is completed, the worker who performs the work, and that employee's work site location. Do this for each task within the process. Then, make appointments to interview each of these personnel at their work site. Schedule the interviews in the order of task completion shown on the work breakdown structure to assist in determining process flow.

At each interview, ask the employee to define and demonstrate, if feasible, the work that is completed within the task. Find out if this work is standardized by governing procedures, who controls these procedures, and the dates they were published. This information will be of importance following the reengineering phase if procedural directives must be updated. Also, ascertain if the work conducted can be automated. If so, specify the hardware and software required to support the task. If not, explain why the process can not be automated. Determine, with the help of the employee, and record if there is a better way of conducting the task.

Identify the work objects involved in the task by recording the task's inputs and outputs. Specify the number of copies of the object, its form (physical or electronic), its format (i.e., document, business form, record of accounts, etc.), the transmission medium used, and the origin/destination task and participant of the work object. Also, specify if and how the work objects and their transfer can be automated.

Describe what triggers the initiation of the task by asking the employee how and by whom he/she is notified that work has been assigned. Record the work notification as a work object that is routed from the person assigning the work to the employee. Also, determine if there are any notifications required upon the completion of the task.

Delineate the task's performance frequency during a single completion of the business process. This will help to identify any cyclic routing within the workflow. Specify its priority (low, routine, high, urgent) in relation to other tasks that the employee

regularly performs. Determine if the work of the task is a support function or a core activity that is strategic to the completion of the final product. Explain how work completion or success is determined. Ascertain if there are any authorizations required in the course of the work, and, if so, identify the approving authority. Add the authorization as a task in the process model.

Next, list the resources (materials, facilities, tools or computer assets) used or consumed during the completion of the task. Record the form of the resource as either electronic or physical. Also, list the source of the resource.

Identify any decisions made or questions answered by the employee in the course of the work. List the choices that can be selected and their resulting actions. Once the process is automated, the workflow tool will record the actual percentage of time each choice is selected.

Repeat these task identification activities until all of the tasks of the process have been identified and a final good or service produced. Update the work breakdown structure with task additions, deletions or modifications, as required. Also, notify the IT Manager of the requirements for task and work object routing automation so that the required infrastructure can be obtained and installed. An example of the completion of the Task Definition Form is provided in the next chapter.

Finally, estimate the value added to the final product by the completion of each task. To do this, take the value of the process' final product from the Business Process Identification Form, and allocate a portion of it to each task. These are subjective decisions that may require the assistance of the steering committee and process owner. Record these values on each of the Task Definition Forms.

6. Specify Performance Measures

Prior to establishing an automated workflow, the performance indicators that will be recorded by the workflow tool must be specified. Harrington specifies three categories of process measurements: effectiveness, efficiency and adaptability (Harrington, 1991).

Process effectiveness is a measure of how well the business process meets the needs and expectation of its external and internal customers. It is a measure of the quality of the product. Examples of effectiveness measures include product:

- Reliability
- Performance or useability
- Durability
- Appearance
- Serviceability

Effectiveness measures could be added to a workflow model as separate quality control processes or as component tasks if completed by automated equipment. The model could include decision points and routing based upon the results of the quality test. The workflow tool would then monitor the number of times a particular choice was made during a specified time period.

Efficiency is a measurement of productivity and level of resource usage. An increase in business productivity or a decrease in the amount of resources used would result in a decrease in the cost to the customer for a good or service. Examples of efficiency measures include the:

- Cycle completion time
- Amount of time spent on rework
- Resources expended per unit
- Amount of value-added to each unit

The efficiency factors are easily supported by workflow management tools with comprehensive functionality. The workflow engine will automatically record the cycle, transfer and queue times of the work object. It will record the amount of resources consumed during a task and calculate the task's cost. It can also be programmed to total

the value added by each task performed during the production of a good or service. The need for rework can be added to the workflow model as a decision within the task that results in cyclic routing. The workflow tool maintains a diary of the tasks completed during the execution of each workflow instance. This diary can then be queried to determine the rate of rework.

Adaptability is a measure of how easily a product or service can be tailored to the needs of a particular customer. Flexibility is the hardest characteristic to measure. However, some possible process adaptability gauges include the:

- Number of available customer service representatives
- Response time to custom orders
- Average time to process special orders as compared to standard orders
- Refusal rate for special orders

The adaptability measures are also supported by workflow tools. The number of available customer service representatives, their schedules and workloads are monitored by the workflow tool. Custom and special orders can be modeled as separate versions of the order processing workflow and their completion times can be monitored and compared to the completion times of standard orders. The refusal of a special order can be modeled as a decision within the special order processing workflow. The workflow tool can then report the number of times that particular flow branch was enacted.

Identify the performance measures to be used for the process under review. Try to use the all of the measures enabled by the functionality of the workflow tool installed within the corporation. At a minimum, select the performance indicators that correspond to the business objectives that were published in the organizational vision statement. Record the selected performance measures, in order of priority, on a copy of the Process Performance Form provided in Appendix A as Figure A-10. Also, make a copy of the Task Performance Form, Figure A-11, for each task, and list and prioritize these same measures on each form. Every task in the process will have its performance rated against

these same measures, although the targeted goal and its priority ranking may differ. List any task specific measures on that task's form. Verify these measures and their rankings with the process owner and the reengineering steering committee.

7. Complete and Verify the Workflow Model

Using the workflow management tool's workflow builder and its procedural documentation, complete the workflow model for the process under review. First, enter all of the data from the Organizational Information, Personnel, and Organizational Resources Forms into the tool's data dictionary. Then, enter the work breakdown structure components and model the flows between the tasks. Ensure that all of the process' decision points and the resulting conditional routing are depicted in the model. Define the work objects and the required resources that must be made available to each employee. Also, program the monitoring of the required performance measures into the system. Examples of completed workflows are included in the next chapter.

If the process contains tasks, routing or work objects that can not be automated, they should still be added to the automated workflow management system. Include electronic notifications of work assignment and completion, and a work object that directs the employee to electronically record the resources consumed while performing the work.

Once the model has been entered into the workflow tool, verify that it is complete by running the tool's model verification feature. Once complete, confirm the accuracy of the model to ensure that the way the process has been modeled is the way it is being performed. Harrington (1991) states that employees deviate from the way business is supposed to be conducted for several reasons:

1. "They misunderstand the procedures.
2. They do not know about the procedures.
3. They find a better way of doing things.
4. The documented method is too hard to do.
5. They are not trained.

6. They were trained to do the activity in a different way.
7. They do not have the necessary tools.
8. They do not have adequate time.
9. Someone told them to do it differently.
10. They don't understand why they should follow the procedures" (Harrington, 1991).

To ensure that the workflow model is accurate and complete, conduct a walk-through of the workflow model. Start at the initial task shown on the workflow model and physically follow the flow and performance of work through the process. Be sure to follow each conditional branch in the model so that no task or route is left unchecked. While conducting the walk-through, verify the components of each task with the task participants. (Harrington, 1991)

8. Install and Test Required Infrastructure

Once the workflow model has been verified, identify the need for any information infrastructure modifications or additions to support the enactment of the workflow model. With the help of the IT Manager, examine the infrastructure diagram provided earlier in the methodology and determine if any additional hardware or software is required to connect all of the workflow participants. Also, verify that all of the systems required to automate the tasks of the process are installed and operational.

Once the IT Manager has the required architecture in place to support the workflow system, test the system's performance by having the process participants simulate a cycle of the automated workflow. Be sure to update the workflow model as required to correct and noted deficiencies and to fully support the current process.

9. Implement and Monitor Automated Workflow

Once all the supporting systems are in place and the involved employees have been adequately prepared, implement the automated workflow system. Allow a sufficient

period for the employees to learn the new system prior to beginning the collection of performance data. During this period, update the workflow model as required to accurately support the existing workflow.

When the model has been proven and the participants are comfortable with the system, allow approximately a month for the workflow management tool to collect the process performance data for use in the reengineering phase of the methodology. The performance data of the present process, as recorded by the workflow management tool, will be used by the change team in identifying areas of the process for improvement. These performance statistics will also provide a baseline against which the value and success of the new process innovation can be measured once implemented.

C. IDENTIFY PROCESS IMPROVEMENTS

Once the existing workflow has been automated using the workflow management tool and while its performance is being measured and recorded, new performance goals for the process are determined. First, the needs of the external customers that purchase and use the process' product are gathered. Then, the process is benchmarked against those of leaders within the industry. Using this data, definitive performance goals are specified for each performance measure. The existing workflow is then analyzed, using these objectives, for possible improvements and new workflow models are constructed. Each model is then simulated to determine its performance characteristics. Finally, the most efficient and effective model is selected for implementation.

1. Consider the Customers' Requirements

The company's customers know best what they require from the business' processes and products. Their requirements, therefore, must be considered in defining the goals of the new process:

> Asking customers what they require of processes serves multiple purposes. In the context of creating visions, the customer perspective furnishes both ideas and objectives for process performance. Seeking

> customer input also demonstrates a desire for a close relationship, although this input must be actually factored into process designs to fully achieve this objective. Finally, new processes may require that customers change their own behavior for the process to be fully effective. (Davenport, 1993)

Obtain a customer listing from the business' sales office for the type of product included in the process being reviewed. Schedule meetings with a representative sample of the customer base to discuss their requirements. Surveys can be created and used to gather the needs of customers that are not within a reasonable traveling distance. However, face-to-face contact should be used when possible to demonstrate a high level of commitment to the customer's requirements. Ask these customers to discuss their needs and desires for the products they purchase from your business, and record their needs. Identify required effectiveness (quality), efficiency (time schedules and cost constraints) and adaptability (flexibility) requirements (Harrington, 1991).

The employees of the organization are also customers of the automated workflow system. Be sure to query all of the workflow participants who have been using the new tool for any ideas they may have on how to improve the existing system and supported process.

2. Benchmark Against Industry Leaders

To maintain and increase their market share, a business must be more innovative than its competitors. To accomplish this, the business must become aware of any new methods and technologies that are employed within its industry. This process of data collection is referred to as benchmarking. "The benchmarking process (BMP) helps you to know yourself, understand your competition, define the best processes, and integrate them into your organization" (Harrington, 1991).

> The sources of benchmarks are varied, ranging from company visits to telephone discussions with consultants and executives in other firms to industry publications and academic case studies. Because third-party accounts of process innovations may gloss over important issues or stop

short of the final chapters of a story, a company is wise to contact benchmarked organizations directly at some point in the benchmarking process. (Davenport, 1993)

Be careful not to restrict your innovations to those already found within your industry. This will only allow your company to catch up with, not exceed, industry standards. "By aspiring only to be as good as the best in its industry, the team sets a cap on its own ambitions" (Hammer and Champy, 1993). Be sure to look throughout private and public markets for innovative ideas. Refer to Chapter Nine of Harrington's book, *Business Process Improvement* (Harrington, 1991), for detailed direction on the benchmarking process.

3. Specify Performance Goals

Consolidate the information gathered from the customers, employees and other companies. Using this data and the performance objectives specified in the organization's vision statement, specify overall process performance goals for each of the performance indicators implemented on the workflow tool. The goals should be stated in quantifiable terms. For example, a performance goal for a cycle time efficiency measure might be *24 hours after order placement*. Record each of these goals in order of priority on the Process Performance Form. Next, apportion these amounts to each of the process' component tasks and record them on each of the Task Performance Forms. Also, add any new performance indicators that may have been identified during the customer interviews and benchmarking process.

4. Reengineer the Workflow

The goal of process improvement is to increase the financial stability and market share of an organization by reducing operational costs and increasing product value to the customer. The costs of production can be reduced by decreasing the number of personnel involved and the resources and time consumed during the process. Product value can be

improved by increasing the quality of the good or service and by increasing the flexibility of the production process to better handle specific product orders from customers. The following are suggestions on how to improve the existing workflow model based upon the principles of reengineering presented in Chapter II. The possibilities for process improvement, however, are endless and depend upon the particular process under review and its identified performance objectives.

Make copies of the automated workflow model with which to work. Do not modify the working model as this will disrupt business operations. As each improvement is identified, carefully record the change on the copy of the model, noting any modifications to the required participants and resources.

a. Delete or Modify Non-Value Added Tasks

There are three types of tasks in a workflow, those that add real value to the customer, those that have some business value but do not directly affect the customer, and those that add no value (Harrington, 1991). Tasks that add no value to the final product should be modified or eliminated to save time and resources, thereby, decreasing product cost.

Print a detailed report of the total cost of the process and each component task. Include a breakdown of costs by each resource consumed. Compare the cost of each task with the value assigned to it on its Task Definition Form. If the cost is higher than the value, ascertain if this task is truly required for the production of the final good or service. To do this, use the decision diagram provided in Figure 38.

First, determine if the task is a core activity that directly contributes to the production of the good or service. The answer to this question should already be recorded on the Task Definition Form. If it is a core activity, then evaluate the work of this task against the needs of the customer. If it contributes to the fulfillment of customer requirements, then it adds real value to the process. If it does not contribute to the

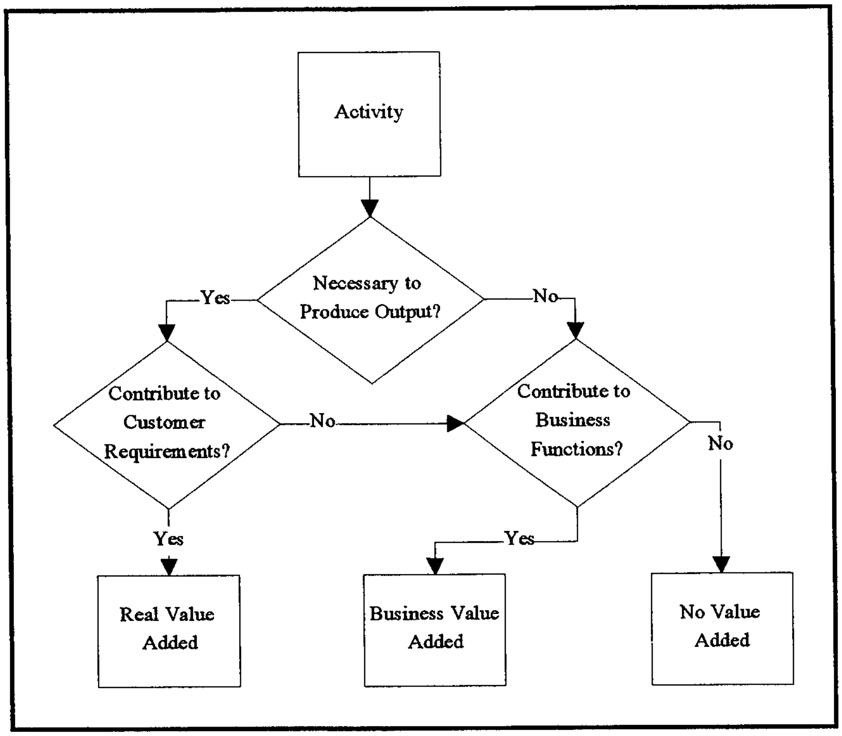

Figure 38. Value-Added Assessment, After Harrington, 1991

fulfillment of customer requirements or is not a core activity, then determine if there is a legitimate business reason for performing this task, such as record keeping or financial reporting.

If the task adds real or business value, design a new and less costly way of accomplishing this task that consumes fewer resources and/or takes less time to complete. If it has no business requirement, delete the task and appropriately adjust the workflow routing.

b. Arrange Tasks in a Natural Order

In traditional processes, tasks were sequenced in strict succession. One person had to complete a task before the next person could begin the following step. This serial routing unnecessarily slowed the cycle time of the process. The use of parallel routing will decrease the cycle time of the process and get the product or service to the market sooner. "Often, activities that were done serially can be done in parallel, reducing

the cycle time by as much as 80 percent" (Harrington, 1991). It should also decrease the total amount of personnel time consumed because workers must no longer wait for the previous employee to finish his/her work prior to beginning a task.

Look at each task in the workflow model and determine if the people performing the succeeding tasks must wait for input from any previous tasks prior to initiating their work. Determine if the process can begin prior to the completion of the previous step. If so, reorganize the order of work object routing to allow the parallel completion of tasks. Adjust the timing of the work notification to occur when there is sufficient data available in the system for the next person to begin his/her task. Figure 39 provides an example of the conversion of a serial process to a process that includes the parallel completion of tasks.

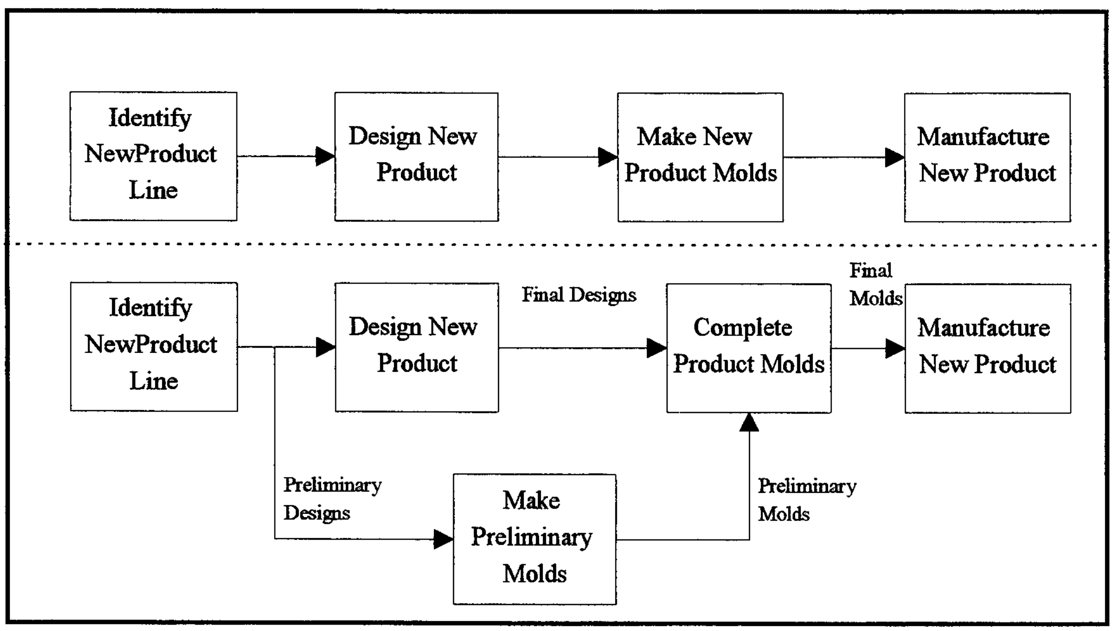

Figure 39. Conversion from Serial to Parallel Routing

c. Place Work Where it Makes Sense

A process that includes the transfer of work objects across departmental boundaries "...is expensive, since it involves a variety of departments plus the overhead

that's associated with tracking all the paper and fitting all the pieces of the process together" (Hammer and Champy, 1993). "Process innovation demands that interfaces between functional or product units be either improved or eliminated..." (Davenport, 1993).

Look at the workflow model and determine if there are any tasks being completed by personnel from different functional specialties and departments. Ascertain if the work of the task really requires the functional expertise already assigned or if it can be completed by another workflow participant. Determine if any of the tasks are being completed by employees with conflicting work schedules. Look at the queue times for these tasks and determine if there are resulting completion delays while employees wait for information. If the work can be performed more easily and quickly by another available participant, reassign the task and adjust the work object routing. This will reduce the number of hand-offs and errors in the workflow, the money spent on personnel, and the overall cycle time of the process. (Hammer and Champy, 1993)

Figure 40 shows a simplified process for obtaining office supplies. The tasks labeled in italics are completed by the company's supply department. The others are

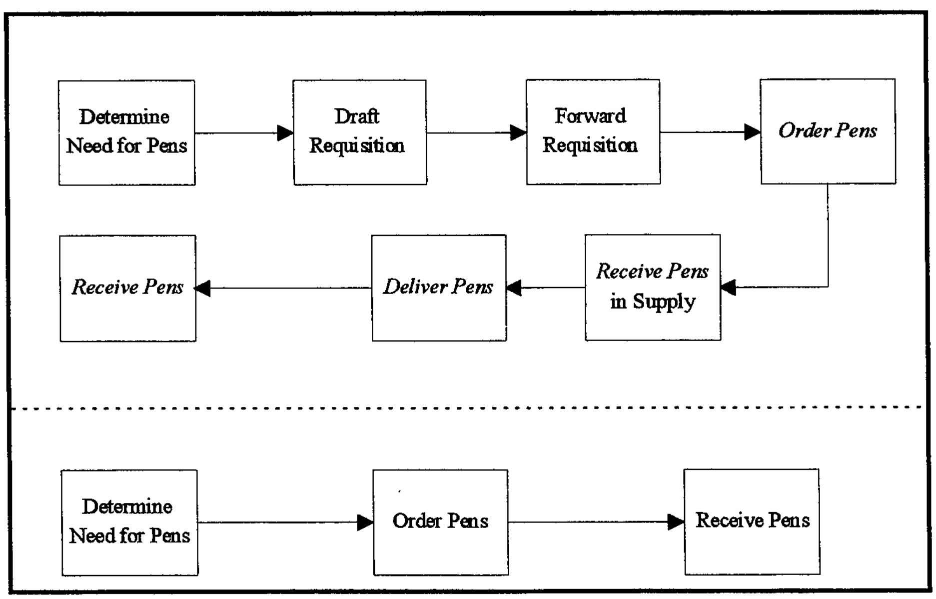

Figure 40. Example of Placing Work Where it Makes Most Sense

completed by a functional office employee. For such a small purchase, the employee requesting the purchase should be given the authorization to order these supplies.

d. Combine Tasks to Reduce Hand-Offs

As discussed in Chapter II, work was broken into its basic steps during the Industrial Age and each step was apportioned to different employees. This required the unnecessary transfer of work objects and lengthened the cycle time of the process. "By eliminating the hand-offs, delays, and errors inherent in a traditional sequential process, a *case worker*-based process can achieve order-of-magnitude improvements in cycle time, accuracy, and cost" (Hammer and Champy, 1993).

Examine the workflow model's component tasks and the work completed within each step. Print a report on the time it takes to complete each task. If the time is short and the task is simple, combine it with the work of previous or following task. This will result in the horizontal compression of the workflow. Figure 41 shows an initial process and a revision that depicts the deletion of an unnecessary work step.

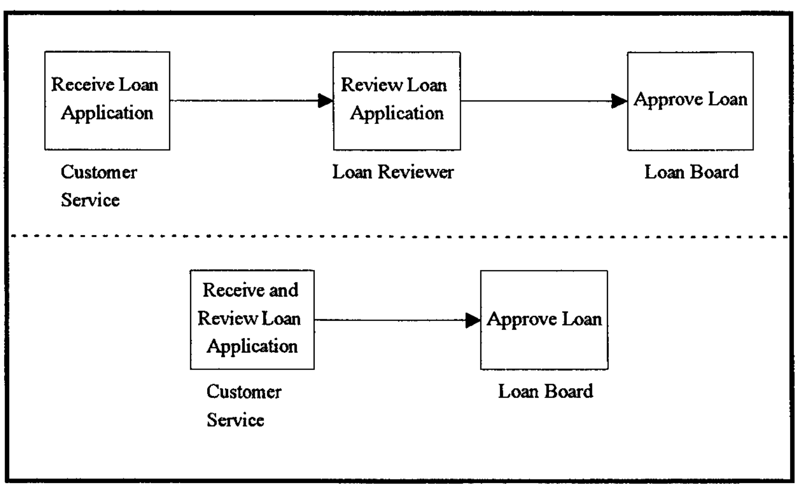

Figure 41. Example of Reducing Hand-Offs

e. Push Decision Making to the Appropriate Task

In a traditional hierarchical organization, decision making occurred at a management level above the workers. "Referring everything up the ladder means decisions get made too slowly for a fast-paced market" (Hammer and Champy, 1993). To speed up these processes, decisions must be pushed down to the personnel performing them.

Examine the workflow model and identify component tasks whose work strictly consists of decision-making or the approval or disapproval of a request. Determine if these tasks can be completed by the employee who routed the work object or request. If so, combine these tasks, modifying the routing of the product of the task. This will result in the vertical compression of the process. The lower level employee normally receives a lower salary and, therefore, the completion of the task at the lower level should result in a lower product cost. "The benefits of compressing work vertically as well as horizontally include fewer delays, lower overhead costs, better customer response, and greater empowerment for workers" (Hammer and Champy, 1993). Figure 42 exemplifies the results of removing an unnecessary decision step. The process that once required the routing of information up to and from a supervisor is now completed by a single employee.

f. Reduce Checks and Controls

"Conventional processes are replete with checking and control steps, which add no value but are included to ensure that people aren't abusing the process" (Hammer and Champy, 1993). With the implementation of the process on the workflow management tool, the need for these controls is virtually eliminated. The processes enacted are managed by the system and managers need not stop the process to check the status of work. They can simply query the workflow engine for status information and can electronically communicate with the assigned employee. They can also enact automatic work prioritization as discussed in the previous chapter.

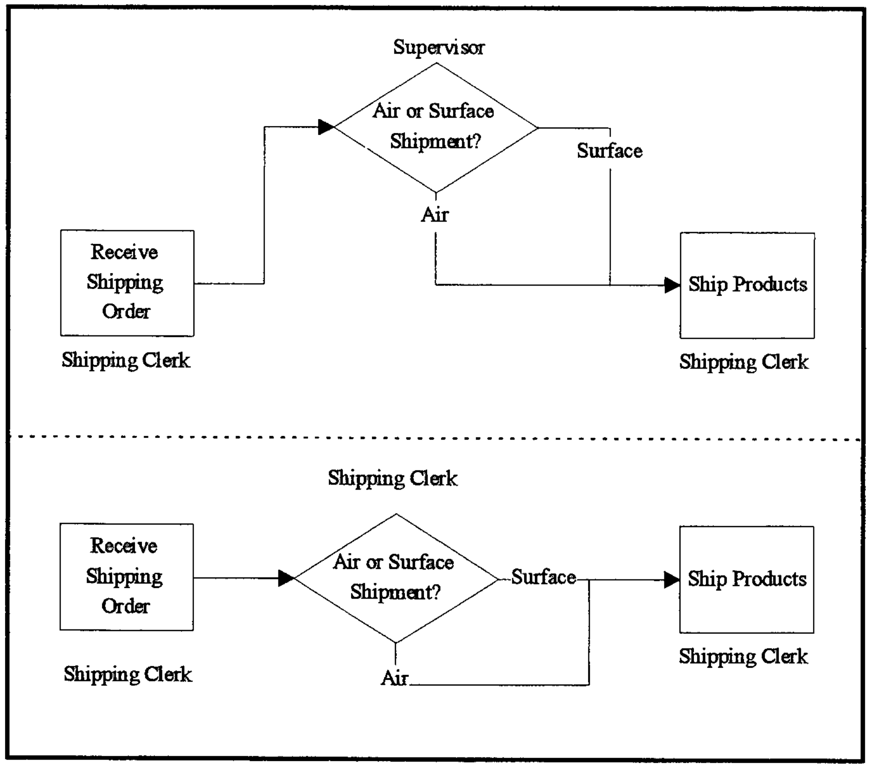

Figure 42. Example of Pushing Decisions to Lowest Level

Examine the workflow model and identify any tasks that are included solely as control or check points. Determine if they are necessary. If they are, ascertain if they can be performed using the workflow management or other automated tool, or by an employee already involved in the process. If they are not required, delete them and appropriately adjust the routing. These steps should reduce process costs. They may also help to improve employee morale and productivity by increasing the authority of the workflow participants. Figure 43 presents an example of the reduction of checks and controls within a simplified workflow.

g. Lessen Cycle Time

As discussed in the previous chapter, the cycle time of the workflow consists of three parts: task completion time, work object transfer time and queue time.

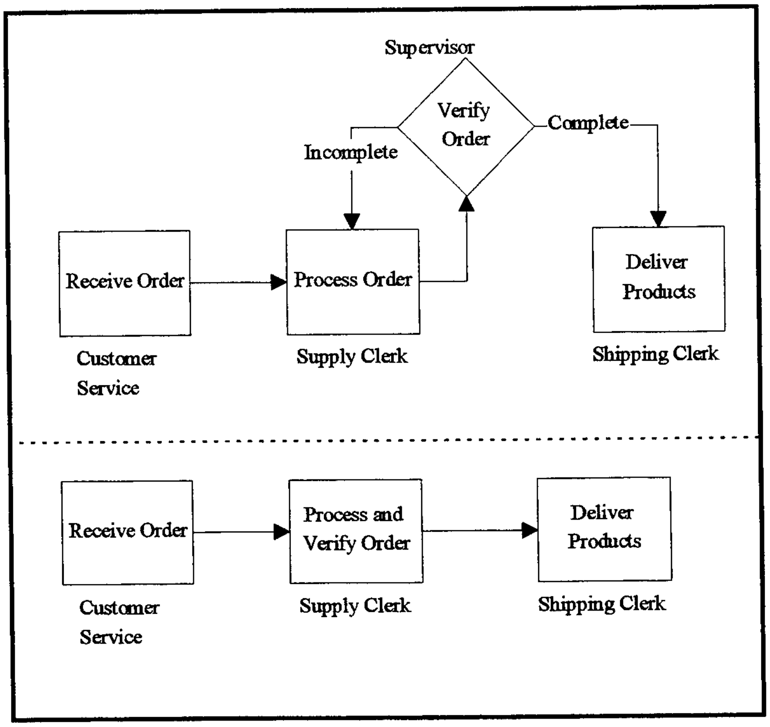

Figure 43. Example of Reducing Checks and Controls

The cycle time directly affects the cost of the product and its time to market. Therefore, these times should be reduced to a level that still guarantees high quality production.

Print a report of these time categories for each task using the workflow tool. Identify the tasks that have high or very low task completion times. Ascertain the reason for the long completion time. Determine if the task could be split between two or more employees, or if an automated tool or change in work procedures could be implemented to speed up the work of the task. If the task completion time is short, determine if the task should remain separate or if it could be combined with the preceding or succeeding tasks.

Look at the workflow model and determine if it contains any cyclic routing patterns. Determine the frequency of the task during a single cycle of the process. If it occurs more than once, determine the reason for the repetition of tasks. If it is due to poor quality production and the need for rework, add quality control procedures into the

workflow. If it is due to unnecessary checks and controls, eliminate these tasks as previously described.

The use of the workflow tool to electronically transfer work objects has already improved the cycle time of the process. However, examine the transfer times between each task to verify that they are short. If any are lengthy, ascertain the reason for the long transfer time. Determine ways to decrease the transfer time, such as the automation of additional work objects and the use of electronic data interchange between workflow participants.

Examine the queue times experienced by each work object. Determine the reason for the delays. If the delay is due to poor employee performance, correct these deficiencies by reassigning the work or providing additional employee training. If it is due to the unavailability of a workflow participant or required resources, follow the ensuing procedures.

h. Eliminate Bottlenecks and Resource Shortages

Bottlenecks are points in the workflow model where the transfer of work objects is slowed. A bottleneck results from the high level of demand for a particular employee or other scarce resource. As a result, work objects must wait in a queue until the resource becomes free. This results in a longer cycle time than necessary.

Generate a report on the workload of each employee and the level of demand for each resource involved in these processes using the workflow tool. Also, examine the report of the queue times for each work object. Determine the reason for any long delays and specify if any of the personnel or resources represent a point of overwork or scarcity. If an employee is overworked, assign some of his/her work to another employee who has the required skills and available time. If a resource is the point of weakness, ascertain if different resources can be used to complete the task or if additional units of that particular resource should be obtained and used. Compare the cost of additional resources against the cost of the queue time incurred in the present workflow.

i. Make Multiple Versions of the Process

"To meet the demands of today's environment, we need multiple versions of the *same* process, each one tuned to the requirements of different markets, situations, or inputs" (Hammer and Champy, 1993). Many existing organizational processes consist of a single workflow that was constructed to handle all possible work requirements:

> Organizations have become accustomed to standardizing, which means trying to satisfy every contingency with a single process. They create one standard -- and complicated -- process that has decision points along its entire length. We now know that in process design it is better to install a decision point up front that can send work along one of several simple processes. (Hammer and Champy, 1993)

This streamlining of complex processes decreases the cycle time as the number of required decisions and their related queue times are reduced. It also improves the value of the company's products by incorporating flexibility into their production operations.

Examine the workflow model and identify each task that includes a decision. For each decision task, evaluate the selection rate of each possible action. If the percentage rate for each choice is relatively even and the information required to make the decision can be made available prior to the execution of subsequent steps, design two separate sub-processes that branch off at an up front decision point. If, however, the required information to make the decision is not available until that point in the process or one of the branches is normally chosen over all of the others, leave the workflow as presently modeled.

j. Capture Information Once, Upstream in the Process

The repetitive entering of identical information at different points along a process is a non-value adding activity. All of the data required during any task within the workflow should be gathered once at an upstream point in the process and stored for use in later tasks. (Linden, 1993)

Examine the workflow model and identify all of the work objects that are depicted as input to any task. Determine if any of these inputs contains redundant information. If so, delete the repetitive collection flow and move the data accumulation point to the task that has the most forward position in the workflow.

k. Provide a Single Point of Contact

A process should have a single employee who will "...answer the customer's questions and solve customer problems...." (Hammer and Champy, 1993). This person will act as a buffer between the process and its customers. This will not only reduce the number of personnel involved in the workflow, it will also improve customer service and response times. (Hammer and Champy, 1993)

Examine the process model and determine if there are multiple interactions with the same customer. If so, count the number of different personnel involved in them. Select a single employee to handle each of these interactions and revise the process model to reflect these changes.

5. Construct New Workflow Models

Incorporate each of the improvements identified into a new workflow model using the workflow management tool and the procedures in Phase II, Step 7. Try to formulate two or three alternative scenarios that negate past process inefficiencies. Label each alternative with a consecutive letter (i.e., Alternative A, Alternative B) and record them at the top of the Process Performance and Task Performance Forms.

6. Simulate Each Workflow Alternative

Run a statistical simulation on each of the workflow improvement alternatives. This simulation allows the testing of design alternatives to ensure the validity of the proposed innovations before committing scarce business resources:

> Simulation provides an alternative approach to testing. Through computer simulation, the new concept can be simulated and the results will be studied beforehand. (Kharwat, 1991)

Computer simulation of a proposed workflow has several benefits. It can help the change team to brainstorm process improvement ideas. It demonstrates how the new process might function and its costs, problems or benefits. Bottlenecks, periods of peak capacity or resource shortages can be identified; employee workloads and work completion times can be measured; and the ability of the new process to meet set operating standards can be tested. As the workflow tool simulates the each scenario, it gathers performance data that can be used to compare design alternatives. A simulation of the workflow can be used to communicate and sell a new workflow plan to management and employees at the operating level. It can also be used to show workflow participants how their work fits into the overall processes of the organization and to pre-train them prior to the implementation the new workflow. (Ardhaldjian, 1994)

Using the user manual instructions of the installed workflow tool, program the simulation mechanism to randomly select each of the decision branches within the workflow. It should enact a large enough number of instances of the workflow to ensure all possible paths are tested. As each model is simulated, collect and print its statistical performance data so that these alternatives can be compared.

7. Select the Most Efficient and Effective Workflow

Record the performance measurements for each alternative on the Process Performance Form. Also, record the performance statistics of each task on its Task Performance Form. Considering the data gathered for each model, determine if each meets the overall performance goals for the process and each of the task goals listed on the Task Definition Form. Look to see if the efficiency, effectiveness and adaptability of the process have been improved. Determine if the model is feasible and identify any limitations or drawbacks. Determine which plan has most support and possibility of

success, saves the most money, and has highest net value. Repeat the Analyze and Reengineer step until a model is found that meets all of the required performance objectives, or those that are of the highest priority to your organization.

D. ESTABLISH SUPPORTING STRUCTURES

Once an improved workflow model has been selected for implementation, any required supporting organizational changes are identified. Necessary modifications or additions to the workflow system infrastructure are also specified. Approval is gained for the new process and the organizational and infrastructure changes are instituted.

1. Identify Organizational Changes

Determine the organizational changes that are required to support the new workflow design. Change must occur "...not only in process flows and the culture surrounding them, but also in organizational power and controls, skill requirements, reporting relationships, and management practices" (Davenport, 1993). Examine the changes that have been made to the workflow model. Specify any resulting personnel changes or reductions, organizational structure adjustments, and management strategy modifications. Describe any new training procedures, performance and compensation measures, and corresponding advancement criteria. Also, identify and draft necessary updates to the procedural regulations that were identified on the Task Definition Forms.

2. Specify the Required Infrastructure

Analyze the present connectivity of the workflow system infrastructure, with the help of the IT manager, and determine if there are any additions or modifications required to support the new workflow model. Specify any new infrastructure procurements and plan a migration strategy for transitioning to the new system.

3. Gain Approval

Brief the reengineering steering committee on the innovated workflow model. Brief them on the cost savings that have already been realized due to the automation of the present workflow. This will demonstrate that the workflow tool has already improved the process and will help to win their support for further process changes. Show management the simulation of the improved workflow and the improved performance measure statistics that result from the implementation of the changes. Also, explain the required organizational and infrastructure modifications and their justification. Then, request their approval to install the new system and its supporting structures.

4. Institute Organizational and Infrastructure Changes

After gaining approval, inform and educate the affected personnel on the procedural, organizational and infrastructure changes. Publish updates to procedural regulations identified on the Task Definition Forms. Also, test the new workflow architecture to assure proper functioning prior to deployment.

Continue to actively manage the resistance to change using the guidelines presented in Phase I, Step 9 of the methodology:

> If process innovation is to succeed, the human side of change cannot be left to manage itself. Organizational and human resource issues are more central than technology issues to the behavioral changes that must occur within a process. (Davenport, 1993)

E. IMPLEMENT AND MAINTAIN IMPROVED WORKFLOW

During this phase of the methodology, the new workflow is implemented and any changes to the workflow configuration are documented as the workflow is maintained. A continuous process improvement program is established to ensure that the present process receives periodic reengineering and that all other corporate processes are automated and improved.

1. Implement the New Workflow

Once the supporting structures are in place and the participants have been trained on the new system and procedures, implement the new workflow model.

> Reengineering isn't just about redesign. It's also about translating new designs into reality. The difference between winners and losers at reengineering doesn't usually lie in the quality of their respective ideas, but in what they do with them. With the losers, reengineering never moves beyond the idea phase into implementation. (Hammer and Champy, 1993)

Once the new workflow system is in place, actively monitor the performance of the workflow to ensure it is functioning as intended. Make any required adjustments.

2. Manage the Workflow Configuration

Actively manage the workflow system's configuration so that the workflow model continues to remain standardized and unaltered by unauthorized personnel. Determine and limit the number of personnel within the organization who are allowed to change workflow models. Document any authorized changes made to the workflow template, including the justification for the change, and institute version control procedures. Maintain copies of the old versions of the models in case there is a need to return to the previous way of doing business. Also, maintain all of the documentation produced during each workflow reengineering project as a starting point for the next reengineering project. (Rickabaugh, 1994)

3. Perform Continuous Improvement

The Workflow Reengineering Methodology is cyclic in nature as depicted in Figure 44. The performance of the improved workflow is continuously monitored and periodically reengineered as required:

> No matter how good you are, how well regarded your products and/or services are, you cannot stop improving. You cannot stand still.

> When you do, you really aren't standing still, you are slipping backward because your competition is constantly improving. The very best have to run to stay the very best, because if you are not improving, there is only one direction you can go, and that's down. (Harrington, 1991)

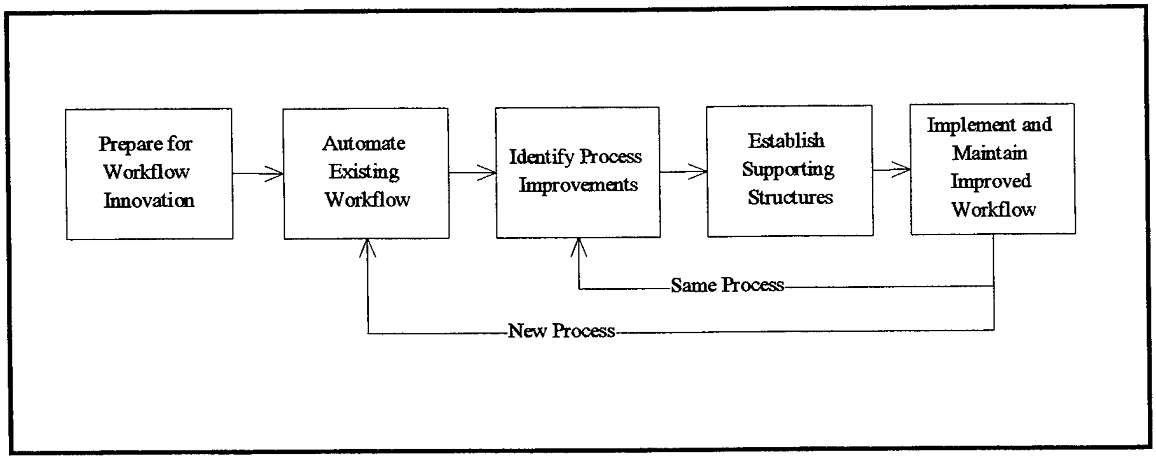

Figure 44. Cyclic Nature of Workflow Reengineering Methodology

Also, new processes are considered for innovation by the same, or a new, change team. As additional processes are defined and automated, their interrelationships should be identified and analyzed in the reengineering project. Eventually, all processes of the organization will be implemented on the workflow management system and can be concurrently analyzed for improvement.

VI. APPLICATION OF WORKFLOW REENGINEERING: A CASE STUDY

This chapter includes a case study of the application of a portion of the Workflow Reengineering Methodology presented in the previous chapter. It first furnishes background information on the organization that sponsored the workflow research. Next, it delimits the scope of the methodology application and identifies the workflow management tool used to apply the included steps. The case study provides a description of a present process from the sponsoring organization and, using data from this workflow, applies several of the steps of the Workflow Reengineering Methodology. The chapter concludes with an analysis of the methodology application and the workflow management tool used in the case study.

A. WORKFLOW PROJECT BACKGROUND

The Port Hueneme Division of the Naval Surface Warfare Center (PHD NSWC), which is a component of the Naval Sea Systems Command, was established following World War II to provide centralized control of and support for the Navy's quickly maturing surface fleet missile systems. Since its inception, the role of PHD NSWC has expanded. The command is now the in-service engineering agent for all of the Navy's fleet combat weapon systems. As such, PHD NSWC is responsible for the development, test and evaluation, installation and life-cycle support of fleet combat platforms, including the Harpoon, Tomahawk, Aegis, Basic Point Defense and Seasparrow systems. Weapons system life-cycle support includes configuration management, logistical support, and technical publication administration. (PHD NSWC, 1995)

PHD NSWC consists of four directorates. Three of the directorates are segregated by the processes they support: Business Operations, Systems Engineering, and Logistics. The fourth is the East Coast Operations Directorate. An excerpt from PHD

NSWC's organizational structure diagram is presented in Figure 45. This figure includes all of the directorates and only those units involved in the workflow used in the case study.

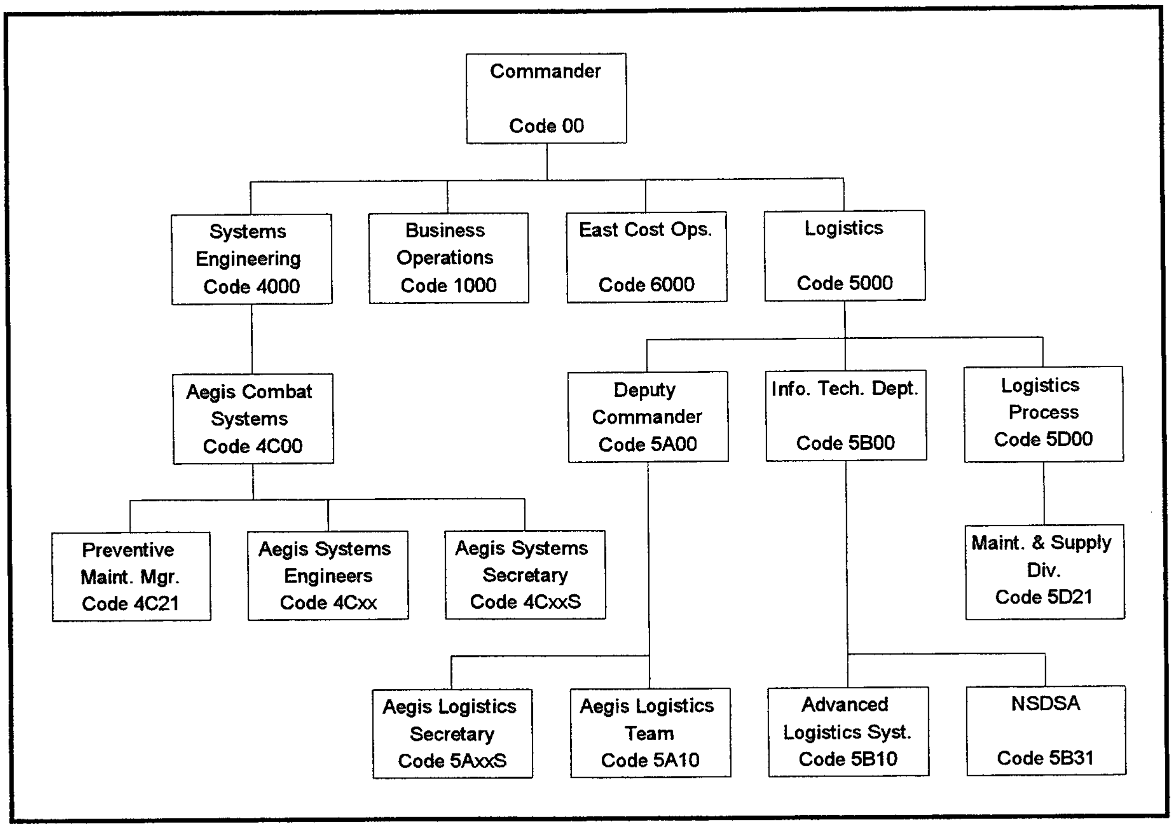

Figure 45. PHD NSWC Organizational Structure

PHD NSWC, Code 5B10, sponsored research into the functionality and use of automated workflow technologies. This study was in response to the installation of a prototype of the Joint Continuous Acquisition and Life-cycle Support (JCALS) system within the command. JCALS is a Department of Defense (DoD) information system created to "...digitize technical and logistics support information, integrate information in existing systems, and reduce development, acquisition, and support costs associated with weapon systems" (CSC, 1994). JCALS embodies an automated workflow management tool called Workflow Manager (CSC, 1994). The purpose of the workflow study was to

identify the most effective use of the workflow management technology within the organization. The Aegis support program was selected by the project sponsor to be the focus of any research data collection efforts due to its relative newness to the fleet.

B. SCOPE OF THE METHODOLOGY APPLICATION

Because the author was required to spend a significant amount of time developing a methodology for conducting BPR and workflow design using a workflow tool, there was limited research time remaining to perform this case study. Consequently, the entire methodology could not be applied. The main objective of this thesis has been to show how business process reengineering can be enabled with the use of an automated workflow management tool. The application of the Workflow Reengineering Methodology, therefore, focuses on the definition, modeling and improvement of a single existing workflow at PHD NSWC. A summary of the steps of the Workflow Reengineering Methodology included in the case study is provided in Figure 46.

First, a process was selected for use in the case study. Next, the tasks of the workflow were identified and their components were defined. The workflow

PHASE II: AUTOMATE EXISTING WORKFLOW

- Step 3: Select a Process for Implementation and Improvement
- Step 4: Construct a Work Breakdown Structure
- Step 5: Define Task Components
- Step 6: Specify Performance Measures
- Step 7: Complete and Verify the Workflow Model

PHASE III: IDENTIFY PROCESS IMPROVEMENTS

- Step 3: Specify Performance Goals
- Step 4: Reengineer the Workflow
- Step 5: Construct New Workflow Models
- Step 6: Select the Most Efficient and Effective Workflow

Figure 46. Steps of the Workflow Reengineering Methodology Included in Case Study

was then implemented on a stand-alone workflow management tool and the process was analyzed for improvement using the time and cost statistics captured in the workflow tool. Finally, new workflow models were developed and the most efficient model was identified.

C. WORKFLOW MANAGEMENT TOOL EMPLOYED

The JCALS Workflow Manager to be implemented at PHD NSWC was not available for local use by the author. Therefore, an alternate automated workflow management tool was used in the case study. Workflow•BPR (*Workflow•BPR*, 1995) is presently under development by HOLOSOFX, Incorporated. A beta version of the software was provided for student use. Workflow•BPR, as evidenced by its name, was designed specifically to support business process reengineering with workflow technology.

The present version of Workflow•BPR is strictly a modeling tool. It does not include a workflow engine with which to execute the workflow. It also does not possess any statistical simulation functionality. Therefore, the workflow implementation and simulation steps of the Workflow Reengineering Methodology could not be demonstrated. Other portions of the methodology were also tailored to the functionality of Workflow•BPR.

D. WORKFLOW REENGINEERING CASE STUDY

The author made a two day visit to PHD NSWC to collect data on the selected workflow. During this visit, process data was captured via interviews conducted with each participant in the workflow. The forms provided in Appendix A were used in the course of the data collection and a representative sample have been included in Appendix B. Figure B-1 and Figure B-2 are, respectively, the completed Organizational Information and Organizational Personnel Forms for the workflow.

1. Phase II: Automate Existing Workflow

The second phase of the Workflow Reengineering Methodology includes the selection of a process for improvement, the identification of the components of the existing workflow, and the design and implementation of the workflow template using the automated workflow tool. In this case study, the work breakdown structure for the selected workflow was constructed, the components of each of the included tasks were defined, performance measures were identified and the workflow model was constructed using Workflow•BPR.

a. Step 3: Select a Process for Implementation and Improvement

As previously mentioned, the workflow project sponsor designated the Aegis program as the organizational unit to participate in any workflow data collection efforts. Therefore, a single process within the Aegis program was selected for inclusion in this case study. This workflow was the processing of an Aegis combat systems platform Technical Manual Deficiency/Evaluation Report (TMDER). It is important to note that the *TMDER Processing* workflow was chosen from the processes of the Aegis program solely due to research time constraints and the author's familiarity with the use of technical manuals and TMDERs in the fleet. The health of the process was not determined because it was not being compared with other processes for reengineering priority.

b. Step 4: Construct a Work Breakdown Structure

The next step of the Workflow Reengineering Methodology performed was the identification of the work breakdown structure for the *TMDER Processing* workflow. First, the purpose and content of the workflow were determined. Next, the component sub-processes and tasks that comprise the workflow were identified. These items were accomplished during an interview with a Technical Editor from the Aegis Logistics Team (Code 5A12). Code 5A12 is viewed as the process owner for the processing of an Aegis TMDER.

The purpose of the *TMDER Processing* workflow is to maintain the accuracy of Aegis combat systems technical manuals provided to fleet units. Technical manuals are provided by PHD NSWC to fleet units for each weapons system under its administration. These publications include data on the effective operation and maintenance of a particular weapons system, and any required personnel training.

A TMDER is a form that is included in the back of a technical manual to be used by a fleet unit to notify the manual's publisher of a problem or error found within a specific technical manual. A copy of a completed TMDER is presented in Figure 47. All surface Navy TMDERs are processed through PHD NSWC. Each TMDER received by PHD NSWC is reviewed and a response is returned to the originating fleet unit. If the deficiency is determined to be valid and requires a change to the technical manual for its correction, the TMDER and response letter are forwarded to the responsible Technical Manual Management Authority (TMMA) for inclusion in the next update of the affected manual. In fiscal year 1994, PHD NSWC processed 324 TMDERs. (Moreno, 1995)

The contents of the *TMDER Processing* workflow were defined by the process owner. First, an Aegis system TMDER is received in the mail from a fleet unit. All TMDERs are received by Code 5B31, the Naval Sea Data Support Activity (NSDSA). Code 5B31 determines if the deficiency noted in the TMDER requires an update to the referenced technical manual. If the deficiency is administrative in nature, such as a notification of a missing page within the received copy of the technical manual change notice, and does not require an update to the manual, Code 5B31 mails a TMDER response letter and copies of any missing pages directly to the fleet unit. If the discrepancy might require a change to the technical manual, it is routed to the Logistics Processes Department, Code 5D21, with a cover memorandum attached (see Figure 48). (Snavely, 1995)

Upon receipt of the TMDER, Code 5D21 determines if the Aegis TMDER contains a technical discrepancy. If it is non-technical, such as the correction of typographic errors, the TMDER and a forwarding memorandum (see Figure 49) are sent

R43671 SA12/THAAWON

(Insert Classif. of TMDER Here and At Bottom of Page) **CLASSIFICATION:** UNCLASSIFIED

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)
(NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3)

INSTRUCTIONS: Insert classification at top and bottom of page. Read the following before completing this form. Continue on 8½" × 11" paper if additional space is needed.

1. USE THIS REPORT TO INDICATE DEFICIENCIES, USER REMARKS, AND RECOMMENDATIONS RELATING TO PUBLICATION.
2. BLOCKS MARKED WITH "*" ARE TO BE FILLED IN BY THE CONTRACTOR BEFORE PRINTING.
3. FOR UNCLASSIFIED TMDER'S, FILL IN YOUR RETURN ADDRESS IN SPACE PROVIDED ON THE BACK, FOLD AND TAPE WHERE INDICATED, AND MAIL. (SEE OPNAVINST 5510.1 FOR MAILING CLASSIFIED TMDERS.)

1. NAVSEA NO. *	2. VOL. PART * REV.	3. TITLE *
S9314-A4-MMA-050	1	400 Hz POWER SUPPLY MK 84 MOD 1

4. REV. DATE OR TM CH. DATE *	5. SYSTEM/EQUIPMENT	6. IDENTIFICATION/NOMENCLATURE (MK/MOD/AN)
A 15 JULY93	UNIT 4 COOLER GROUP	MK 9 MOD 1

7. USER'S EVALUATION OF MANUAL (*Check Appropriate blocks*)

	A. EXCELLENT		B. GOOD		C. FAIR		D. POOR		E. COMPLETE		F. INCOMPLETE

8. GENERAL COMMENTS

RECEIVED 27 JAN 1995

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO. A.	PARAGRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS
2-4-157	3	1			C1 CAPACITOR, ELECTROLYTIC : 580μF, 40 V CHANGE TO: C1 CAPACITOR, ELECTROLYTIC : 5800μF, 40 V THE CAPACITOR VALUE IS 5800μF VICE 580μF. AEGIS TFBR/TMDER ACTION DATE FORWARDED: 1-27-95 NO. : R43671 CODE: 4L15 DUE : 3-26-95

10. ORIGINATOR AND WORK CENTER (PRINT)	11. ORIGINATOR'S RANK, RATE OR GRADE, AND TITLE	12. DATE SIGNED
FC2 Fox CF02	E-5/FC2	01 DEC. 1994

13. SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15. AUTOVON/COMM. NO.
W.B. Dutchard FCC(SW)	KC Mt LT	

16. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)
USS CHANCELLORSVILLE (CG-62) FPO-AP 96662-1182 (P)

17. THIS SPACE ONLY FOR NSDSA

A. CONTROL NO	B. COG ISEA	C. DATE			D. PRIORITY	E. TRANSMITTED TO
		R21451				
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R43671						4C22

NAVSEA 9086/10 (REV.6-85) S/N 0116-LF-090-8651 (REPLACES 4-84 EDITION & NAVSEA 4160/1 DESTROY STOCK) (N-Known All) **CLASSIFICATION:** ENCLOSURE (1) 4C00/4-26-95

Figure 47. Example of a TMDER

N-44126-95V

3-9-95

RECEIVED 09 MAR 1995

5A42/6 JUN 95

4160.3
5B31 -MS/8904
02-Mar-95

TAA MK13/4

5A42/Taylor

MEMORANDUM

From: Code 5B31
To: Code 5D20

Subj: FORWARDING OF TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT

Ref: (a) NAVSEAINST 4160.3

Encl: (1) TMDER N44126

1. The TMDER(s) listed in enclosure (1) is forwarded for processing as a matter under your cognizance.

2. As required by reference (a), a final response to the originator is required for each TMDER within 90 days. Request a copy of each final response be provided to code 5B31.

3. Additional information may be obtained from Mike Snavely, Code 5B31, extension 2-2970.

9-12-95: Sent back to Robin Wellesley, Code 5A42, X97 for missing data.

Michael D. Snavely
Michael D. Snavely
By direction

Figure 48. Example of a Forwarding Memorandum from Code 5B31

4160
5D20P-RF

MEMORANDUM

From: Code 5D20
To: Code

Subj: TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORTS

Ref: (a) NAVSEAINST 4160.3A
(b) NSWSESINST 4790.1H
(c) Responsibilities and Procedures for Navy Maintenance and Material Management (3M) System Planned Maintenance System (PMS), Standard Operating Procedures Manual

Encl: (1) TMDER Serial No.

1. In accordance with references (a) through (c), enclosure (1) is forwarded for your action. In order to comply with the 90 calendar day response criteria of reference (a), your reply to the originator is required no later than . Forward a copy of the response letter to NAVSEA (SEA-04TD), NSDSA (Code 5B61), FTSCPAC (Code 401A) and two copies to Code 5D20P.

2. If after review you determine the problem is not under PHD NSWC cognizance, or should be transferred to another department, notify Code 5D20P, extension 2-8110.

Ted H Hetherington

TED H. HETHERINGTON
By direction

Copy to:
5D00 (w/o encl)
5D20
5D20P
(TMDER)

Figure 49. Example of a Forwarding Memorandum from Code 5B21

to Code 5A12 for comment and response. If the discrepancy is technical, the TMDER is forwarded with a forwarding memorandum to the Aegis Combat Systems Department for review and comment by the engineer responsible for the applicable Aegis system. (Suller, 1995)

Within the Combat Systems Department, Code 4C21 receives all technical Aegis system TMDERs and, based upon the particular technical manual under question, assigns and forwards the TMDER to an Aegis systems engineer (Code 4Cxx) for review and comment. During a technical review, the engineer might interact with the system's contractor for technical information. (Moreno, 1995)

The assigned employee, either Code 5A12 or Code 4Cxx, reviews the deficiency noted in the TMDER and formulates a response. The Team Secretary then drafts a "Response to Technical Manual Deficiency/Evaluation Report (TMDER)" letter, that includes a paragraph containing the reviewer's comments. The draft is reviewed for accuracy and content by the commentator and the Team Leader. The Team Secretary then smoothes the response letter for the Team Leader's signature and hand carries it to their office. Once signed, the Team Secretary mails the response letter and an enclosed copy of the TMDER to the originating fleet unit. Copies of the letter and TMDER are also forwarded to each participant in the workflow, all affected ships and contractors, and the TMMA. Figure 50 is a copy of a TMDER response letter. Except for the generation of the rough and smooth response letters using a word processor, the work objects and their transfer are manual. (Moreno, 1995)

The resulting work breakdown structure for the *TMDER Processing* workflow is depicted in Figure 51. There are three sub-processes within the workflow: *Receive TMDER*, *Review TMDER* and *Respond to TMDER*. Each of these sub-processes is then broken into its component tasks. The tasks of each sub-process, shown at lowest level of the diagram, combine to form the steps of the workflow.

2-21-95

"Info Copy"

5A12/ THANNOM

4790
Ser 4C15-EL/0091
08 FEB 1995

From: Commander, Port Hueneme Division, Naval Surface Warfare Center
To: Commanding Officer, USS CHANCELLORSVILLE (CG 62) (3M Coordinator), FPO AP 96662-1182

Subj: RESPONSE TO TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)

Ref: (a) Technical Manual S9314-A4-MMA-050

Encl: (1) USS CHANCELLORSVILLE (CG 62) TMDER R43671 of 1 Dec 94 (TMDER Status Code 07)

1. Thank you for submitting enclosure (1) as a recommended change to reference (a). We agree with your comments. The value of capacitor "C1" is 5800uF.

2. This correction will be placed in a Technical Manual (TM) change portfolio. When a sufficient number of TMDERs accumulate or a revision update to the TM is approved, these corrections will be incorporated.

3. Point of contact is E. LeMay, Code 4C15, DSN 551-6979, (805) 982-6979.

4. The interest and participation of FC2 Fox are appreciated and are important factors in improving the AEGIS System/Equipment Manual Program.

B. FUJIKAWA
By direction

Copy to:
4A01 R/F (w/o encl)
4C00 (w/o encl)
4C02 (2) (w/o encl)
4C10
4C15 (EL)
4C21 (CC)
5A12 (BT)
5B31 (MS)
5D20 (RF) (2)

Writer: E. LeMay, Code 4C15, X2-6979
Typist: H. Glazer, 7 Feb 95

Figure 50. Example of a TMDER Response Letter

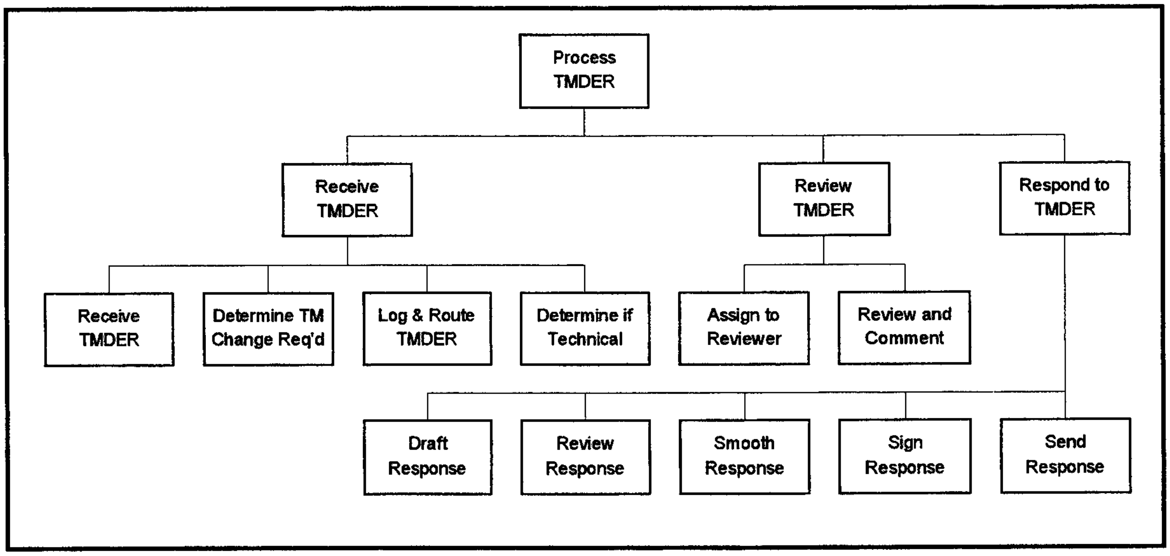

Figure 51. Work Breakdown Structure for *TMDER Processing* Workflow

c. Step 5: Define Task Components

Once the tasks of the workflow were identified, the components of each task were defined. Code 5A12 first identified the employee responsible for the completion of each task in the workflow. Each participant was then interviewed by the author in the order that their task occurred within the process. During each interview, the employee was asked to comment on the accuracy of the flow of tasks in the workflow, and to define and demonstrate the work performed during their task. They were also asked to define the remaining task components: work objects, resources, rules, routing and time. The author used the Task Definition Forms to record this task data during the interviews. An example of a completed Task Definition Form is contained in Appendix B as Figures B-3 through B-6.

PHD NSWC does not yet have a workflow management tool installed throughout the organization. Therefore, the workflow could not be implemented on the tool, and the time and resource consumption data could not be automatically collected as prescribed in the Workflow Reengineering Methodology. Consequently, the process participants were asked to estimate their resource consumption, and the amount of time

they spend completing the task and transferring the work object to the next participant in the workflow. A Task Duration Worksheet was created to record the time information. An example of a completed Task Duration Worksheet is included in Appendix B as Figure B-7.

Due to time constraints on data collection and the lack of unit cost statistics available at PHD NSWC, much of the cost data gathered in this workflow was estimated:

> It is acceptable to use approximate costs, estimated by using current financial information. Obtaining accurate costs may require an enormous amount of work, without much additional benefit. (Harrington, 1991)

The resources consumed within this workflow include **personnel** time; paper, envelopes and postage **materials**; computer and reproduction **equipment** time; and **facilities** time. The unit costs for these resources were estimated as follows:

- **Personnel:** The 1995 civil service pay scale with a 40% markup for benefits was used to estimate the yearly pay of each employee. Pay step five was used for the determination of each base pay rate. This rate was divided by an estimated work year of 2,080 hours to determine an hourly pay rate. This rate, in turn, was divided by 60 to determine a cost per minute. The resulting personnel costs are shown in Table 4.
- **Materials:** The cost of supplies was estimated as $0.01 per page of paper, $0.05 per envelope and $0.32 postage per envelope.
- **Equipment:** Copy machine, computer and printer costs were estimated as $.02 per employee minute of use.
- **Facilities:** Building, utilities and maintenance costs were randomly estimated as $.05 per employee minute of use.

The value of a TMDER response was not available. There are approximately 600 technical manuals and 90 fleet units supported by the Aegis system

Pay Grade	Yearly Base Pay	Yearly Pay with Benefits	Hourly Rate	Cost per Minute
GS-05	$22,643	$31,700	$15.24	$0.25
GS-07	$27,241	$38,137	$18.34	$0.31
GS-11	$40,321	$56,449	$27.14	$0.45
GS-12	$48,326	$67,656	$32.53	$0.54
GS-14	$67,908	$95,071	$45.71	$0.76

Table 4. Estimated General Schedule (GS) Pay Rates

support team. The team received and responded to 121 TMDERs in fiscal year 1994. The range of possible technical manual deficiencies was very broad. The value of any technical manual correction was, therefore, extremely difficult to quantify. Therefore, this amount was left blank on the each of the Task Definition Forms. (Moreno, 1995)

d. Step 6: Specify Performance Measures

During the data collection visit, time was not available to discuss the performance measures for the workflow with the senior management officials at PHD NSWC. However, in the course of interviewing the process owner and participants, their overriding concerns for process improvement were for reduced cycle time. Presently, the maximum allowable response time for a TMDER is 90 days. This requirement was established by NavSea Manual S0005-AA-PRO-010/TMMP (NavSea, 1991). Each workflow participant agreed that the cycle time of the process could and should be reduced to provide improved customer service to the fleet.

Another efficiency performance measure, reduced cost, was also selected for the workflow. This is a standard performance measure in most reengineering projects that is used to compare process design alternatives. A completed Process Performance Form is included in Appendix B as Figure B-6. The effectiveness and flexibility measures were not included in this demonstration because it was not possible to monitor them without having implemented the workflow on an on-line or simulation system.

e. Step 7: Complete and Verify the Workflow Model

Following the author's return from PHD NSWC, the workflow data contained in the Task Definition Forms was entered into the Workflow•BPR tool. First, all of the organizational and resource data were entered into the tool's data dictionary. Next, the process components from the work breakdown structure were drawn and the workflow model was constructed.

Within Workflow•BPR, a workflow model is constructed in sub-process segments. A sub-process segment is the workflow steps that occur between, and are dependent on, adjacent decision nodes. Each segment's breakdown structure is modeled independently. "For each sub-process, you create a series of definitions, each of which represents an alternative way of performing that sub-process" (*Workflow•BPR User's Manual*, 1995). The Workflow•BPR tool contains a reasoning engine that is then used to define the process' business rules. These conditions and parameters determine how each process segment interconnects to form a unique version of the workflow.

The Workflow•BPR tool, presently, does not allow the printing of the reasoning diagram. Figure 52 shows a re-creation of the reasoning diagram for the *TMDER Processing* workflow. The diamonds represent decision nodes and the hexagons denote possible decision outcomes (parameters). The rectangles at the bottom of the diagram denote the three sub-processes contained in the workflow. The squares directly above the sub-processes each symbolize a particular way of conducting that sub-process. The lines from the parameters to the sub-process components dictate how each sub-process will be completed based upon that decision outcome.

There are two decision nodes included in the *TMDER Processing* workflow. First, there is a decision about whether or not the correction of the reported deficiency will require a change to the technical manual. Then, there is a decision about whether or not the nature of the discrepancy is technical and requires research and response by a systems engineer. Based upon the possible results of these two decision nodes, there are three potential workflow cases that could occur for any TMDER

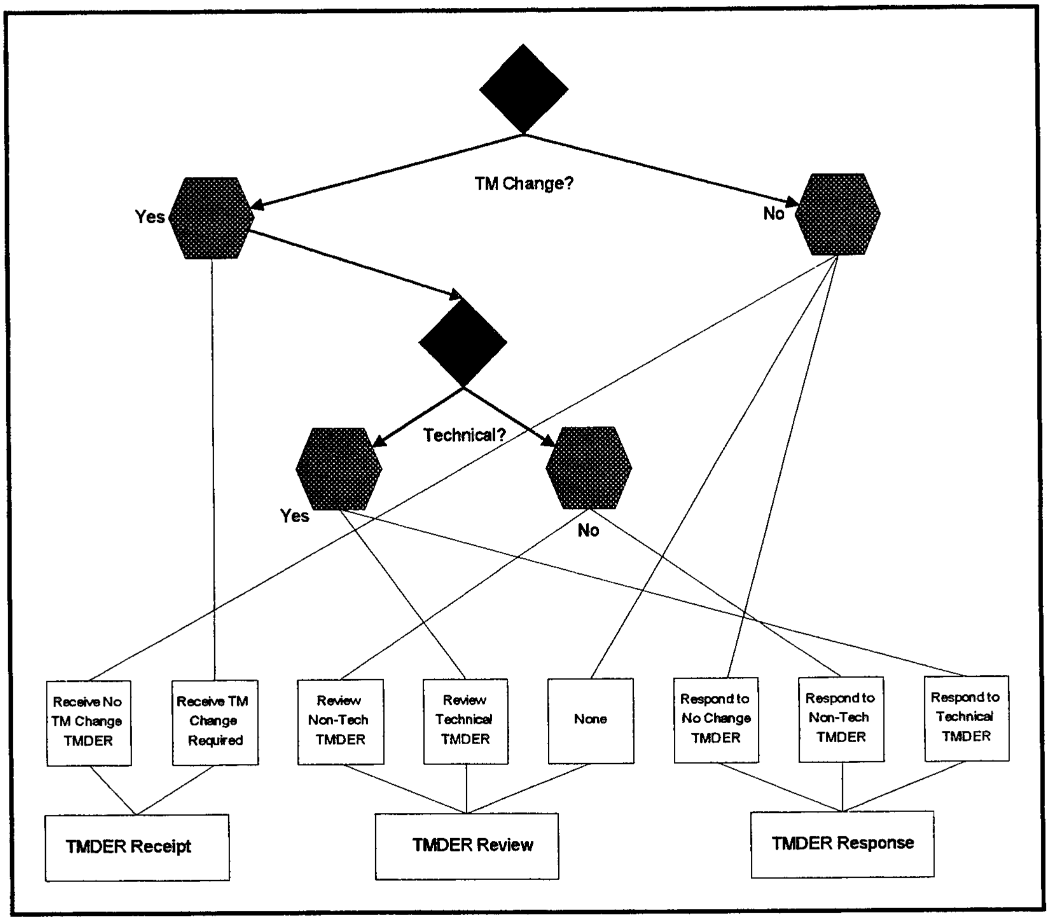

Figure 52. Reasoning Diagram for the *TMDER Processing* Workflow, After *Workflow•BPR*, 1995

received. They include the processing of a TMDER that requires no technical manual change; a technical TMDER; and a non-technical TMDER. The workflow models for each of these process cases are included in Appendix C as Figures C-1 through C-3. The Workflow•BPR tool also does not allow the display, printing or manipulation of the overall workflow. It displays only one case of the process at a time. A simplified version of the overall workflow model, therefore, is sketched in Figure 53.

Because no workflow tool has been implemented within PHD NSWC and the tool used is unfamiliar to their employees, the workflow model was not verified by the workflow participants. Code 5A12, however, verified the accuracy of the workflow

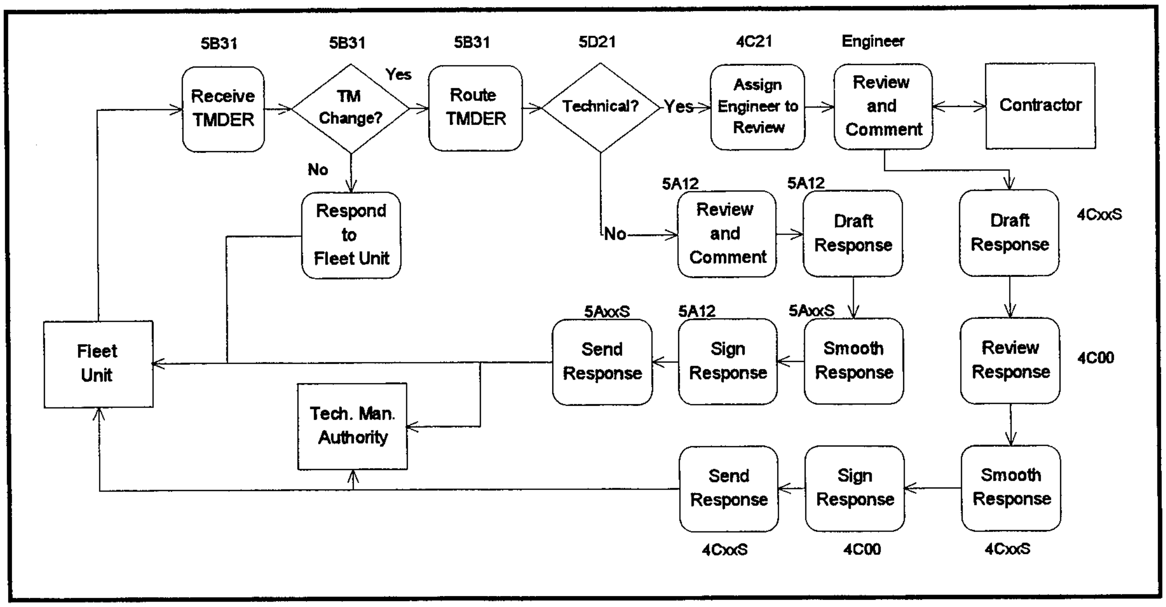

Figure 53. Simplified *TMDER Processing* Workflow

model presented in Figure 53. Also, each workflow case generated in the workflow tool was validated as being complete by the workflow tool.

2. Phase III: Identify Process Improvements

The third phase of the Workflow Reengineering Methodology involves the identification of process performance goals and the reengineering of the workflow to meet those objectives. Within this case study, the *TMDER Processing* workflow was reengineered using the process performance statistics provided by PHD NSWC personnel. Considering these process improvements, new workflow models were designed.

It is important to note that the reengineering conducted was based upon estimated data. Therefore, the process cost and improvement figures given should not be considered accurate. The conceptual process improvements are, however, considered legitimate.

a. Step 3: Specify Performance Goals

Specific performance goals for the performance measures of reduced cost and cycle time were not determined for the *TMDER Processing* workflow. The goal of

this reengineering effort was simply to realize any amount of decrease in these measures. Because there were no specific goals delineated, performance goals were not apportioned to the tasks of the process and the Task Performance Forms were not used.

b. Step 4: Reengineer the Workflow

Within this step of the Workflow Reengineering Methodology, the *TMDER Processing* workflow was analyzed by the author for improvement. During the reengineering effort, each of the process improvement suggestions presented in Chapter V was considered. A list of these considerations is provided in Figure 54.

1. **Delete or Modify Non-Value Added Tasks**
2. **Arrange Tasks in a Natural Order**
3. **Place Work Where it Most Makes Sense**
4. **Combine Tasks to Reduce Hand-Offs**
5. **Push Decision Making to the Appropriate Task**
6. **Reduce Checks and Controls**
7. **Lessen Cycle Time**
8. **Eliminate Bottlenecks and Resource Shortages**
9. **Make Multiple Versions of the Process**
10. **Capture Information Once, Upstream in the Process**
11. **Provide a Single Point of Contact**

Figure 54. Business Process Improvement Considerations

Table 5 is a consolidated report of the estimated cycle times (in minutes) and resource costs for each task in the original workflow. Personnel and Facilities costs were calculated using only task times. No cost was assessed for queue times. Transfer

Task	Employee	Process Case	TIME (mins) Task	Transfer Out	Queue	Total Time	Personnel	Transfer Personnel	Materials	COSTS Equipment	Facilities	TOTAL COST
Receive TMDER	5B31	All	10	0	0	10	$ 5.40	$ -	$ -	$ -	$ 0.50	$ 5.90
Determine if Requires TM Change	5B31	All	60	0	0	60	$ 32.40	$ -	$ -	$ -	$ 3.00	$ 35.40
Respond to Fleet	5B31	No TM Change	60	1440	0	1500	$ 32.40	$ -	$ 0.40	$ 0.20	$ 3.00	$ 36.00
Route TMDER	5B31	Tech TMDER, Non-Tech TMDER	20	15	960	995	$ 10.80	$ 8.10	$ 0.02	$ 0.02	$ 1.00	$ 19.94
Determine if Technical	5D21	Tech TMDER, Non-Tech TMDER	45	30	240	315	$ 13.95	$ 7.50	$ 0.04	$ 10.02	$ 2.25	$ 33.76
Assign Engineer to Review	4C21	Tech TMDER	5	5	0	10	$ 2.25	$ 1.25	$ -	$ -	$ 0.25	$ 3.75
Review Technical TMDER	4Cxx	Tech TMDER	480	0	1920	2400	$ 259.20	$ -	$ -	$ -	$ 24.00	$ 283.20
Comment on Technical TMDER	4Cxx	Tech TMDER	30	5	0	35	$ 16.20	$ 2.70	$ -	$ -	$ 1.50	$ 20.40
Draft Technical TMDER Response	4CxxS	Tech TMDER	15	5	0	20	$ 3.75	$ 1.25	$ 0.01	$ 0.32	$ 0.75	$ 6.08
Review Technical TMDER Response	4C00	Tech TMDER	30	5	60	95	$ 22.80	$ 1.25	$ 0.02	$ 0.02	$ 1.50	$ 25.59
Smooth Technical TMDER Response	4CxxS	Tech TMDER	15	5	0	20	$ 3.75	$ 1.25	$ 0.06	$ 0.32	$ 0.75	$ 6.13
Sign Technical TMDER Response	4C00	Tech TMDER	10	5	60	75	$ 7.60	$ 1.25	$ -	$ -	$ 0.50	$ 9.35
Send Technical TMDER Response	4CxxS	Tech TMDER	15	1440	0	1455	$ 3.75	$ -	$ 0.37	$ -	$ 0.75	$ 4.87
Review and Comment	5A12	Non-Tech TMDER	60	0	0	60	$ 32.40	$ -	$ -	$ -	$ 3.00	$ 35.40
Draft Non-Technical TMDER	5A12	Non-Tech TMDER	15	5	0	20	$ 8.10	$ 2.70	$ 0.02	$ 0.42	$ 0.75	$ 11.99
Smooth Non-Technical TMDER	5AxxS	Non-Tech TMDER	15	5	0	20	$ 3.75	$ 1.25	$ 0.02	$ 0.32	$ 0.75	$ 6.09
Sign Non-Technical TMDER	5A12	Non-Tech TMDER	10	5	0	15	$ 5.40	$ 1.25	$ -	$ -	$ 0.50	$ 7.15
Send Non-Technical TMDER	5AxxS	Non-Tech TMDER	15	1440	0	1455	$ 3.75	$ -	$ 0.37	$ -	$ 0.75	$ 4.87
Totals for No Change TMDER			130	1440	0	**1570**	$ 70.20	$ -	$ 0.40	$ 0.30	$ 6.50	$ **77.30**
Totals for Technical TMDER			735	1515	3240	**5490**	$ 381.85	$ 24.55	$ 0.46	$ 0.70	$ 36.75	$ **454.37**
Totals for Non-Technical TMDER			250	1500	1200	**2950**	$ 115.95	$ 20.80	$ 0.45	$ 0.78	$ 12.50	$ **160.50**

Table 5. TMDER Processing Workflow Performance Statistics Table

Personnel costs were based transfer time and the pay grade of the employee physically transporting the work object between workflow participants.

Times and costs for each of the three process cases are totaled at the bottom rows of the table. The processing of a technical TMDER costs $454.37 and is the most expensive of the three process cases. It is also the most lengthy at 5,490 minutes. This is due to the amount of time required by the engineers to research and respond to a technical discrepancy. The processing of a TMDER that requires no technical manual change is the least costly workflow case at $77.30 and takes the least amount of time to complete, 1,570 minutes. The processing of non-technical TMDER costs $160.50 and takes 2,950 minutes to complete. As shown in the table, personnel costs are, by far, the most expensive resource consumed by each of the workflow cases.

The purpose of the TMDER Processing workflow is to evaluate and address a reported technical manual discrepancy. The only tasks within the present process that were determined to add value to the final product of a TMDER response include *Receive TMDER, Determine if Requires TM Change, Determine if Technical, Review and Comment* and *Send TMDER Response*. These tasks are required in order for the TMDER to be processed by the appropriate employee and a response sent to the originating fleet unit [Reengineering Consideration 1: Delete or Modify Non-Value Added Tasks]. The other tasks involve administrative activities and routing decisions that were deemed to be unnecessary steps. The value added tasks occur in a natural order and should not be rearranged [Reengineering Consideration 2: Arrange Tasks in a Natural Order]. The non-value added tasks present in the current workflow should be deleted. This can be accomplished, and the overall cycle time and cost of the process greatly reduced, by automating the *TMDER Processing* workflow [Reengineering Consideration 7: Lessen Cycle Time].

PHD NSWC Code 5A12 is currently developing Interactive Electronic Technical Manuals (IETMs) to replace its paper manuals. The present goal of the program is to distribute the IETMs via compact disk to afloat units. The IETM is being

written in an object oriented format. Each chapter, section and paragraph is assigned a data label that allows it to be independently retrieved and manipulated. (Dimond, 1995)

Because of the IETMs object oriented format, each section or paragraph of a technical manual could be assigned a TMMA who would be responsible for the upkeep of that portion of the manual. Discrepancy notifications could then be routed directly from the fleet unit to the TMMA responsible for the section of the manual under question. This would be Code 5B31 for administrative discrepancies, an engineer from Code 4Cxx for technical discrepancies and Code 5A12 for non-technical discrepancies. The TMMA should then be the single point of contact for any for customer service issues relating to a technical manual under their oversight [Reengineering Consideration 11: Provide a Single Point of Contact].

The TMDER form should be contained on the IETM disk in electronic format. The sailor submitting the discrepancy notice could use a personal computer to type the technical manual name and number, affected chapter, section and/or paragraph label and discrepancy directly into the TMDER form template. The completed TMDER could then be electronically sent to PHD NSWC via the ship's satellite communications system.

The electronic TMDER would then be received at PHD NSWC and entered directly into the JCALS Workflow Manager as a *TMDER Processing* workflow. The electronic TMDER form should contain a block for the originating sailor to check that specifies whether or not the discrepancy requires a change to the technical manual and if the discrepancy is of a technical nature. These are simple decisions that the originator could easily be entrusted to make.

Upon the receipt of the TMDER at PHD NSWC, the appropriate software package on the workflow system could then assign the TMDER a control number. Based upon the information blocks checked by the sailor, the workflow management tool would electronically route the TMDER to the appropriate Aegis program TMMA for review and response. There then would be no need for Code 5D21 or Code 4C21 to be involved in

the workflow. These positions simply route the TMDER to the appropriate reviewer. In the automated process, the workflow tool would make routing decisions and track TMDER status. [Reengineering Consideration 3: Place Work Where it Makes Sense]

A TMDER response template should be created for use by the TMMAs that is in smooth format. The employee making the comments, Code 5A12 or 4Cxx, could directly enter their comments into the TMDER response template, thereby creating a smooth version of the response for forwarding to the fleet unit. There then would be no need for the TMDER response review and smoothing steps. Consequently, Codes 5AxxS and 4CxxS would not be participants in the workflow. [Reengineering Consideration 4: Combine Tasks to Reduce Hand-Offs]

The *Review Response* and *Sign Response* tasks are included in the original workflow as a final check for proper content and format of, and approval for, the TMDER response letter prior to mailing to the fleet unit. These steps could easily be removed from the workflow. The TMDER reviewer, who is the technical expert on and TMMA for that section of the manual, could electronically sign and send the response directly to the fleet unit without the Team Leader's review or authorization. If the comments are found in error after later review, the TMMA could revise the TMDER comments prior to incorporation into the appropriate technical manual. The Team Leader's time is the most expensive of all of the workflow participants. The deletion of these steps would decrease cycle time and the cost of producing a technical TMDER response. [Reengineering Consideration 5: Push Decision Making to the Appropriate Task and Reengineering and Consideration 6: Reduce Checks and Controls]

With the automation of the workflow, there does not appear to be any bottlenecks remaining in the process. The only area of concern is that the workflow participants may work different hours as a result of flexible work schedules presently in place at PHD NSWC. This may result in queue times for TMDERs and should, therefore, be addressed by the process owner. [Reengineering Consideration 8: Eliminate Bottlenecks and Resource Shortages].

The reengineered *TMDER Processing* workflow proposed herein still involves three workflow cases. These include the processing of a No Technical Manual Change Required TMDER, a Technical TMDER and a Non-Technical TMDER [Reengineering Consideration 9: Make Multiple Versions of the Process]. However, there would be no employee making routing decisions within the new workflow. Workflow case selection would be made automatically by the Workflow Manager based upon pre-defined choices made by the submitting unit.

Within the reengineered workflow, there are no repetitious inputs. All data required throughout the process is received only once. The TMDER is one input and the comment from the contractor is another. These inputs are both gathered at the appropriate places within the workflow. Therefore, no workflow modifications are required to modify the timing of the capture of information. [Reengineering Consideration 10: Capture Information Once, Upstream in the Process]

This reengineered workflow was referred to as Alternative A. A second workflow alternative, Alternative B, was also created during the reengineering effort. This alternative was developed based upon the premise that the overall process would not be automated. This alternative was created because the IETM program and the JCALS system have not yet been deployed at PHD NSWC. Alternative B could serve as an interim improvement until the automated IETM and workflow infrastructures are installed and operational.

The work steps included in Alternative B are identical to those contained in Alternative A. There are, however, two differences. Code 5B31 would complete the tasks that would have been completed by the Workflow Manager in Alternative A. Also, the work object transfers within the workflow would remain manual as in the present process.

c. Step 5: Construct New Workflow Models

Based upon the results of the reengineering step, new workflow models were constructed for the *TMDER Processing* workflow. Alternative A, which assumes that the process can be completely automated, is depicted in Figure 55. The time and cost statistics for this workflow are provided in Table 6. The workflow cases built using the Workflow•BPR are presented in Appendix C as Figures C-4 through C-6.

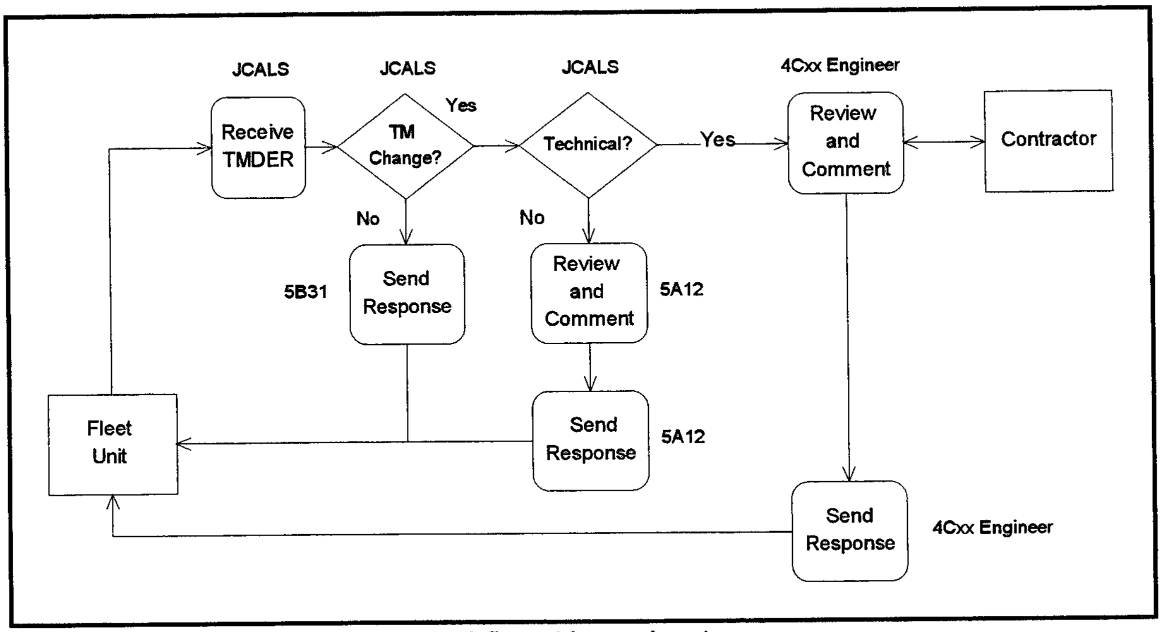

Figure 55. *TMDER Processing* Workflow Alternative A

The cycle times for each workflow case were significantly reduced: a 96% reduction for the processing of a *No Change TMDER*, 56% reduction for a *Technical TMDER*, and 97% reduction for a *Non-Technical TMDER*. These time savings were due to the elimination of most transfer times due the use of electronic routing. A five minute satellite time was assigned for the sending of the TMDER response to a fleet unit. The time reductions were also due to the elimination of most of the queue times. The queue time for the *Review Technical TMDER* remains due to the time spent by the

Task	Employee	Process Case	TIME (mins) Task	Transfer Out	Queue	Total Time	COSTS Personnel	Transfer Personnel	Materials	Equipment	Facilities	TOTAL COST
Receive TMDER	JCALS	All	0	0	0	0	$ -	$ -	$ -	$ 0.02	$ -	$ 0.02
Determine if TM Change	JCALS	All	0	0	0	0	$ -	$ -	$ -	$ 0.02	$ -	$ 0.02
Respond to Fleet	5B31	No TM Change	60	5	0	65	$ 32.40	$ -	$ -	$ 0.20	$ 3.00	$ 35.60
Determine if Technical	JCALS	Tech, Non-Tech	0	0	0	0	$ -	$ -	$ -	$ 0.02	$ -	$ 0.02
Review Technical TMDER	4Cxx	Tech TMDER	480	0	1920	2400	$ 259.20	$ -	$ -	$ 0.10	$ 24.00	$ 283.30
Send Technical TMDER Response	4Cxx	Tech TMDER	10	5	0	15	$ 5.40	$ -	$ -	$ 0.20	$ 0.50	$ 6.10
Review and Comment	5A12	Non-Tech TMDER	60	0	0	60	$ 32.40	$ -	$ -	$ 0.10	$ 3.00	$ 35.50
Send Non-Technical TMDER	5A12	Non-Tech TMDER	10	5	0	15	$ 5.40	$ -	$ -	$ 0.20	$ 0.50	$ 6.10
Totals for No Change TMDER			60	5	0	**65**	$ 32.40	$ -	$ -	$ 0.24	$ 3.00	**$ 35.64**
Totals for Technical TMDER			490	5	1920	**2415**	$ 264.60	$ -	$ -	$ 0.36	$ 24.50	**$ 289.46**
Totals for Non-Technical TMDER			70	5	0	**75**	$ 37.80	$ -	$ -	$ 0.36	$ 3.50	**$ 41.66**

Table 6. Alternative A Performance Statistics

engineer waiting for a response from a contractor. Time reductions also resulted from the elimination of nine non-value added tasks and their resulting task completion times from the overall workflow.

As a result of the task time reductions the overall costs for each workflow case were decreased. The deletion of tasks resulted in personnel cost reductions, alone, of $37.80 for a *No Change TMDER*, $117.25 for a *Technical TMDER*, and $78.15 for a *Non-Technical TMDER*. The personnel costs for the time spent transferring paper documents were eliminated. Material costs for paper, envelopes and postage were eliminated due to the automation of the work objects and the removal of the forwarding memorandums. Equipment costs, however, were slightly higher due to the additional amount of computer use by all workflow participants. It is important to note that the costs of implementing the workflow management tool were not included in the equipment costs of Alternative A. These costs might increase the overall cost of this alternative. Table 7 summarizes the overall time and cost improvements realized as a result of the improvements to the original workflow. These values were also entered into the Process Performance Form contained in Appendix B.

Workflow Case	Cycle Time	Cost
No Change TMDER	- 1,505 mins.	- $ 41.66
Technical TMDER	- 3,075 mins.	- $164.91
Non-Technical TMDER	- 2,875 mins.	- $118.84

Table 7. Alternative A Performance Measure Improvements

Alternative B, which improves the present manual process by deleting the non-value added tasks while maintaining manual work routing, was also modeled. The overall workflow is shown in Figure 56. The workflow case diagrams drawn with

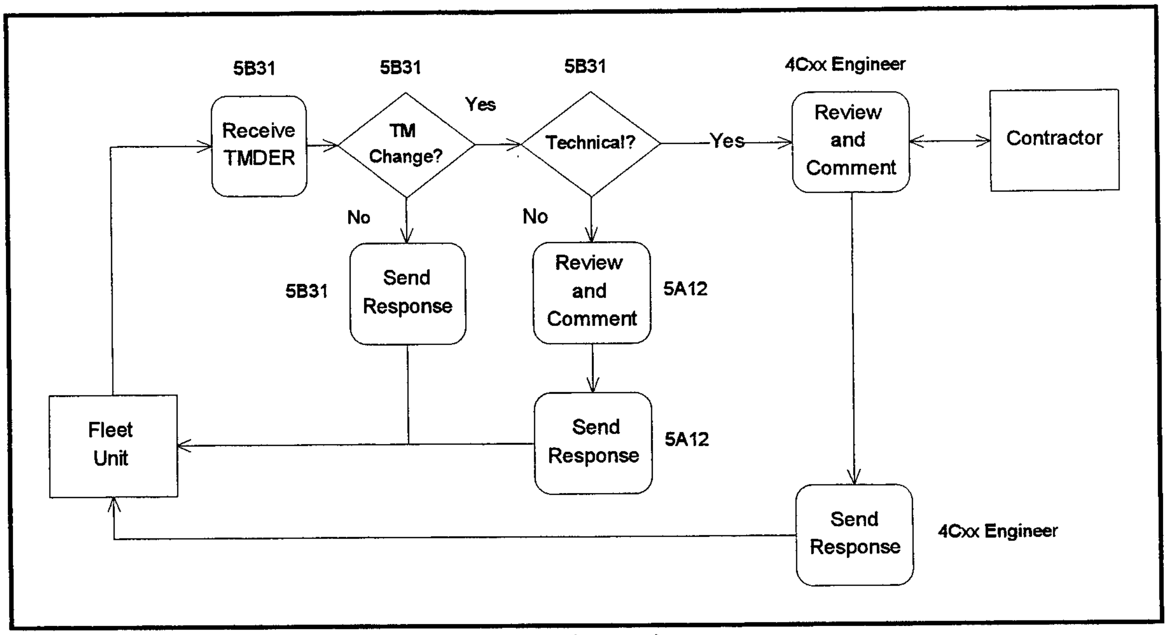

Figure 56. *TMDER Processing* Workflow Alternative B

Workflow•BPR are included in Appendix C as Figures C-7 through C-9. The time and cost statistics for this alternative are presented in Table 8.

The cycle time for the processing of a *No Change TMDER* remained constant because this workflow case was not altered from its original form. The transfer times for the tasks included in this alternative remained constant because the routing of work objects continued to be manual. The cycle times for the remaining workflow cases decreased 22% for the processing of a *Technical TMDER* and 36% for the *Non-Technical TMDER* due to the elimination of the nine non-value added tasks and their associated task and transfer times.

The cost of the *No Change TMDER* process remained constant. The personnel, materials, equipment and facility costs for the remaining two cases decreased due to the elimination of the nine non-value added tasks. The performance improvements for Alternative B are listed in Table 9 and were also recorded on the Process Performance Form in Appendix B.

				TIME (mins)				Transfer		COSTS		
Task	**Employee**	**Process Case**	**Task**	**Transfer Out**	**Queue**	**Total Time**	**Personnel**	**Personnel**	**Materials**	**Equipment**	**Facilities**	**TOTAL COST**
Receive TMDER	5B31	All	10	0	0	10	$ 5.40	$ -	$ -	$ -	$ 0.50	$ 5.90
Determine if Requires TM Change	5B31	All	60	0	0	60	$ 32.40	$ -	$ -	$ -	$ 3.00	$ 35.40
Respond to Fleet	5B31	No TM Change	60	1440	0	1500	$ 32.40	$ -	$ 0.40	$ 0.20	$ 3.00	$ 36.00
Determine if Technical	5B31	Tech TMDER, Non-Tech TMDER	45	30	240	315	$ 24.30	$ 7.50	$ 0.04	$ 10.02	$ 2.25	$ 44.11
Review Technical TMDER	4Cxx	Tech TMDER	480	0	1920	2400	$ 259.20	$ -	$ -	$ -	$ 24.00	$ 283.20
Send Technical TMDER Response	4Cxx	Tech TMDER	15	1440	0	1455	$ 8.10	$ -	$ 0.37	$ -	$ 0.75	$ 9.22
Review and Comment	5A12	Non-Tech TMDER	60	0	0	60	$ 32.40	$ -	$ -	$ -	$ 3.00	$ 35.40
Send Non-Technical TMDER	5A12	Non-Tech TMDER	15	1440	0	1455	$ 8.10	$ -	$ 0.37	$ -	$ 0.75	$ 9.22
Totals for No Change TMDER			130	1440	0	**1570**	$ 70.20	$ -	$ 0.40	$ 0.30	$ 6.50	$ **77.30**
Totals for Technical TMDER			610	1470	2160	**4240**	$ 329.40	$ 7.50	$ 0.37	$ 0.02	$ 30.50	$ **377.83**
Totals for Non-Technical TMDER			190	1470	240	**1900**	$ 102.60	$ 7.50	$ 0.37	$ -	$ 9.50	$ **130.03**

Table 8. Alternative B Performance Statistics

Workflow Case	Cycle Time	Cost
No Change TMDER	- 0 mins.	- $ 0.00
Technical TMDER	- 1,250 mins.	- $ 76.54
Non-Technical TMDER	- 1,050 mins.	- $ 30.47

Table 9. Alternative B Performance Measure Improvements

d. Step 7: Select the Most Efficient and Effective Workflow

Following the design of new workflow templates, the performance statistics for each workflow design alternative were compared to determine which workflow design was the most efficient. The performance improvements for each workflow alternative are summarized in Table 10. As previously stated, no effectiveness measures were included in this case study.

Workflow Case	Alternative A		Alternative B	
	Time	Cost	Time	Cost
No Change TMDER	- 1,505 mins.	- $ 41.66	- 0 mins.	- $ 0.00
Technical TMDER	- 3,075 mins.	- $164.91	- 1,250 mins.	- $ 76.54
Non-Technical TMDER	- 2,875 mins.	- $118.84	- 1,050 mins.	- $ 30.47

Table 10. Performance Measure Improvement Comparison of Alternatives

Alternative A was found to be more efficient than Alternative B both in terms of reduced cycle time and cost. Alternative A, therefore, would provide the most benefit to the organization if implemented. Both alternatives, however, offer cost and time savings over the original workflow. Again, it is emphasized that these workflow templates

should not be considered accurate due to the use of estimated data in the process of their creation.

E. ANALYSIS OF WORKFLOW REENGINEERING APPLICATION

The applied steps of the Workflow Reengineering Methodology provided the author an effective road map for collecting process data and using that data to build and reengineer the workflow. The steps occurred in a logical order and provided sufficient background information and guidance to successfully steer the completion of each task.

The use of the data collection forms provided with the methodology made the process of defining the task components and gathering workflow data quite simple. The pre-filled forms helped to ensure that all necessary questions were asked during each interview and that the required data was recorded for later use. The collection of data was also made easier at PHD NSWC because the author sent a letter describing the purpose of the visit and the data that was to be collected. The process owner, in turn, sent a memorandum to each workflow participant informing them of the types of questions that they would be asked during the interviews. As a result, they were prepared for the interviews and had supporting forms and task data available.

The Workflow•BPR tool used to demonstrate a portion of the Workflow Reengineering Methodology incorporated all of the components of the workflow model: work breakdown structure, roles, rules, routing, resources and time. The personnel (roles) and resource names and usage rates were easily entered into the tool's data dictionary. Cycle time statistics were also easily entered into Workflow•BPR. The workflow tool allowed the entry of time statistics for task completion, work transfer and work or transfer delays.

The actual drawing of the workflow model with Workflow•BPR was challenging. Most workflow tools enable the construction of an overall workflow picture that contains all decision points and alternative work object flows. In contrast, Workflow•BPR builds workflow cases in sub-process segments that represent alternative ways of conducting that

portion of the workflow. Each sub-process segment must be independently modeled and later linked together using a reasoning diagram. This process is quite complex and difficult to learn.

The construction of the reasoning diagram used to tie the sub-process alternatives together, however, was straightforward. Each decision point in the workflow became a condition and the result of each decision became a parameter. The only challenge was to tie each condition to the appropriate sub-process segment alternative. Once the connections were made, the workflow cases were simple to generate and verify.

Once the workflow cases were built, they were rigorous to manipulate during the reengineering step. The workflow tool displays only one case of the process at a time. The side-by-side comparison of alternative workflow designs was not supported by the workflow tool. To compare alternatives, the diagrams and performance statistics for the each workflow had to printed and manually compared. There is also no way to view the entire workflow. This makes the overall process harder to envision and makes workflow alteration more time consuming because it is difficult to determine which sub-process segment to modify. As depicted throughout this chapter, the author generated simplified graphical representations of the overall workflow with which to work.

Despite the difficulties encountered during the building of the workflow model, the workflow tool effectively maintained, calculated and displayed the workflow performance statistics of time and cost for each workflow case. The tying of time and cost statistics to the workflow model and the automatic calculation of process statistics freed the author from the laborious completion of the calculations required to determine cycle times and resource costs. The tool allowed the resulting process data to be viewed as data tables. This data could then be manipulated and additional calculations made through the creation of new tables. The tool also automatically updated the time and cost statistics for each reengineered workflow case. These features greatly assisted in the reengineering effort.

The workflow tool, although challenging at times, greatly assisted the author with the process improvement endeavor. It enabled the on-line capture and manipulation all of

the components of the workflow model. It also provided documentation of the process improvement endeavor that could be used as a starting point for future reengineering efforts. The Workflow Reengineering Methodology was easily tailored to the limitations encountered with the use of the workflow tool.

VI. SUMMARY, CONCLUSION AND LESSONS LEARNED

This chapter provides a summary of the Workflow Reengineering Methodology. It concludes with lessons learned in the course of the thesis research and suggested topics for future study.

A. SUMMARY OF METHODOLOGY

In this thesis, the author first overviewed the principles of BPR and four methodologies for its accomplishment. It was determined that each of the reengineering methodologies was incomplete or inefficient. They were found to use historic or estimated information in their process models and reengineering steps. They also were not supported by an independent automated tool.

The author then discussed the components of a workflow, and the functionality and benefits of automated workflow management tools. It was shown that automated workflow management technologies can singularly support process reengineering through on-line process modeling, work automation, simulation and real-time capture of performance data for use in the process improvement steps. It was reported that there were no satisfactory methodologies found for workflow design or, more specifically, workflow design that included business process reengineering.

Next, the author delineated the Workflow Reengineering Methodology that was created to enable BPR through the use of automated workflow management software. The Workflow Reengineering Methodology incorporates and enacts the principles reengineering throughout its steps. In Phase I, Prepare for Workflow Innovation, the business cycles of the organization are determined and verified through the evaluation of business objectives and products. The information infrastructure of the activity is analyzed and improved through the installation of the automated workflow management technology and its open systems structure.

> Simply contemplating workflow automation sparks improvements. Analyzing and writing down an existing sequence of work steps forces companies to examine their procedures -- sometime for the first time. (Verity, 1993)

There is an analysis of the organizational environment, with concentration on identifying the change levers or obstacles present within the company and the resources available to support any change initiatives. Also, a proactive change management plan is enacted with the goal of improving employee acceptance, education and participation in the reengineering effort.

During Phase II of the methodology, Automate Existing Workflow, the products of the business, and the processes that create them, are identified. The health of each process is determined and the most inefficient and ineffective process is chosen for immediate reengineering. The remaining processes are prioritized for future improvement. A process owner is designated to be the sole person responsible for the effective and efficient functioning of each process. The components of each task within the process are defined and the work of the process is analyzed for automation. The component tasks of the process are prioritized and the value of the final product is apportioned to the process' tasks.

The workflow is then modeled using a workflow management tool. The completeness and accuracy of the workflow model are verified through software validation, enactment and refinement. The implementation of the workflow on the automated workflow tool, alone, improves the process by standardizing tasks, controlling and automating the flow of work, freeing personnel resources to do more important work, and reducing the number of errors due to incorrect routing, loss or delays. It also improves business cycle time through the significant reduction of work object transfer times. Accurate real-time performance data is collected for use in the process improvement phase, negating the need for, and the inherent errors of, human estimation.

The change team can watch the process in action and query the tool's data base for process statistics that aids in the early identification of process strengths and weaknesses.

In Phase III, Identify Process Improvements, the needs of the customers, suggestions of employees and the innovations found in industry are gathered and used to re-shape the process. The reengineering principles are employed using a verified workflow model and accurately collected process performance data. On-line workflow models are easily modified. None of the process data need to be reentered into the system or redrawn because it is stored within the single tool. Also, any workflow improvements can be simulated to test their performance prior to implementation, and these simulations used to gain change approvals and to pre-train employees.

In Phase IV, Establish Supporting Structures, organizational changes that are required to support the new workflow system are considered and made upon approval. The supporting workflow infrastructure is also updated to enable the enactment of the new process. Additional education and training are provided to the affected employees.

In Phase V, Implement and Maintain Improved Workflow, the new workflow model is put into operation. Any subsequent changes to its configuration are documented and the workflow is continually improved. Each cycle of the methodology incorporates additional processes into the automated system. Eventually, all of the organization's processes are concurrently improved.

B. CONCLUSION

All businesses, public or private, must continue to improve their business practices if they are to survive:

> The world of the industrial revolution is giving way to an era of a global economy, powerful information technologies, and relentless change. The curtain is rising on the Age of Reengineering. Those who respond to its challenges will write the new rules of American business. All that is needed is the will to succeed and the courage to begin. (Hammer and Champy, 1993)

However, the will and courage to undertake process improvement are not sufficient for a company to succeed at reengineering. Supporting tools and methodologies with which to perform these process improvements are crucial.

The Workflow Reengineering Methodology promises to be an effective methodology that can be used with a supporting workflow tool to improve any organization's business processes. The methodology and its use of a supporting workflow tool meet the characteristics of an effective change methodology specified in Chapter II. The methodology is complete, applicable, friendly, consistent, supported, successful, documenting and enabled by tools (DODINST 8020.1-M, 1993). The methodology is comprehensive, covering the process improvement effort from the identification of a need for change to the final implementation and maintenance of the improved workflow. The method can be applied to any type of process and is, therefore, a consistent tool. It has been designed to be easy for all personnel to learn and understand. Simple forms and detailed guidance has been provided for all phases and steps. The methodology suggests employee training topics and is well documented. The workflow tool and the forms used in the methodology document the workflow design and reengineering process as each step is accomplished. The method is enabled by a single workflow management tool that significantly improves and eases the reengineering effort through its graphical modeling tool, simulation features, real-time performance data collection and reporting features.

Finally, a portion of the proposed methodology was applied in a case study using workflow data from the Naval Surface Warfare Center, Port Hueneme Division. The use of the methodology and its supporting data collection forms successfully supported and streamlined the reengineering process.

C. LESSONS LEARNED

The search for methodologies for BPR and workflow design was formidable. The newness of these process innovation techniques and the proprietary nature of the consulting marketplace made these procedures difficult to locate. Most sources provided

only a fragment of the overall concepts or steps. It was, therefore, necessary to gather numerous sources from which to pull relevant ideas that could be incorporated into a coherent and comprehensive methodology.

The creation of the Workflow Reengineering was quite time consuming and intellectually challenging. Much effort was required to research each step and piece together a final product. It was impossible to incorporate actions for every possible contingency without making the description lengthy and difficult to comprehend.

During the application of the methodology, the capture of required process data was greatly simplified because the personnel to be interviewed during the visit were trained in the principles of process thinking. Not only did they understand what the purpose of the data collection visit was, they had more of an idea of what information was required from them. Therefore, they were more adequately prepared for the interview and the data collection effort was much simpler.

It was also determined that it is critical that an organization have unit-based costing in place prior to undertaking a reengineering project. Especially in a public organization, employees may not be aware of the value of a good or service, or of the quantity or cost of the resources they consume in the completion of their tasks. Determining this information is quite time consuming and requires the assistance of an experienced financial expert. This data collection process can bog down the progress of the reengineering effort and can cause a decreased amount of team motivation. If unit-based costing is in effect at the time of the process improvement initiative, much time and effort could be saved for the reengineering team.

D. TOPICS FOR FUTURE RESEARCH

There are two related topics that require additional research. These areas were not sufficiently addressed in this thesis due to time and scope limitations.

1. Test and Refine Workflow Reengineering Methodology

Due to the time limitation and the lack of an installed workflow tool at PHD NSWC, the Workflow Reengineering Methodology was not fully tested. To be validated and refined, the methodology as a whole should be used throughout a complete reengineering project. The reengineering roles should be established and an automated workflow system should be put into place. Each step of the methodology should then be completed and the overall methodology analyzed and improved.

2. Develop Supporting Workflow Tool

An automated workflow management tool should be developed that supports the Workflow Reengineering Methodology from start to finish. The tool should incorporate an easy to use graphical user interface that prompts the user for the required information. The information should then be automatically incorporated into the workflow model. To streamline the reengineering process, the tool should also enable the side-by-side display, simulation and comparison of design alternatives and their performance statistics.

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APPENDIX A. WORKFLOW REENGINEERING FORMS

ORGANIZATIONAL INFORMATION FORM

Organization Name:

Location(s):

Hours of Operation:

Business Cycles	**Project Ranking**

Figure A-1. Organizational Information Form

ORGANIZATIONAL PERSONNEL FORM

Unit Name: **Location:**

Position Title	No.	Pay Rate	Overtime	Working Hours

Figure A-2. Organizational Personnel Form

ORGANIZATIONAL RESOURCES FORM

Resource Name	Location	Quantity	Unit Cost	Availability

Figure A-3. Organizational Resources Form

BUSINESS PROCESS IDENTIFICATION FORM for Business Cycle ____________________

Product	Form	Cost	Value	Business Process	Freq.	Priority	Condition

Figure A-4. Business Process Identification Form

Process Name	Changeability	Performance	Business Impact	Customer Impact	Total

Figure A-5. Process Condition Worksheet, After Harrington, 1991

TASK DEFINITION FORM

Task Name:	Organizational Unit:
Employee Position:	Location:

Description of the Work Performed:

Governing Procedures	Controlling Entity	Date Issued

Can Work be Automated? ________

Hardware and Software Required to Automate:

Better Way of Conducting Task:

Frequency within Single Process Cycle:	Priority:

Support/Core Activity

When is Work Complete?

Required Authorizations: **Approving Entity:**

Page 1 of 4

Figure A-6. Task Definition Form Page One

TASK DEFINITION FORM

Work Object:			**# Copies**
Input/Output	**Electronic/Physical**	**Transmission Medium:**	
Source/Destination Position:		**Task:**	
Format:			**Automatable?**

Work Object:			**# Copies**
Input/Output	**Electronic/Physical**	**Transmission Medium:**	
Source/Destination Position:		**Task:**	
Format:			**Automatable?**

Work Object:			**# Copies**
Input/Output	**Electronic/Physical**	**Transmission Medium:**	
Source/Destination Position:		**Task:**	
Format:			**Automatable?**

Work Object:			**# Copies**
Input/Output	**Electronic/Physical**	**Transmission Medium:**	
Source/Destination Position:		**Task:**	
Format:			**Automatable?**

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Figure A-7. Task Definition Form Page Two

TASK DEFINITION FORM

Resources Consumed	Form	Source Task	Source Entity

Page 3 of 4

Figure A-8. Task Definition Form Page Three

TASK DEFINITION FORM

Decision/Question:

Choice	Result/Action

Decision/Question:

Choice	Result/Action

Decision/Question:

Choice	Result/Action

Value Added to Final Product by Task Completion:

Page 4 of 4

Figure A-9. Task Definition Form Page Four

PROCESS PERFORMANCE FORM

Process: ____________

Performance Measure	Goal	Alternative A	Alternative B	Alternative C

Page __ of __

Figure A-10. Process Performance Form

TASK PERFORMANCE FORM Task Name ____________________				
Performance Measure	**Goal**	**Alternative A**	**Alternative B**	**Alternative C**
Page __ of __				

Figure A-11. Task Performance Form

APPENDIX B. PHD NSWC WORKFLOW FORMS

ORGANIZATIONAL INFORMATION FORM

Organization Name: Port Hueneme Division, Naval Surface Warfare Center

Location(s): Port Hueneme, California

Hours of Operation: 6 a.m. - 5 p.m.
Command supports flexi-hours. Core times 9 a.m. - 11 a.m. and 1 p.m. - 3 p.m.

Business Cycles	**Project Ranking**
System Engineering Development	
System Test and Evaluation	
System Production	
System Life-Cycle Support	

Figure B-1. PHD NSWC Organizational Information Form

ORGANIZATIONAL PERSONNEL FORM

Unit Name: PHD NSWC **Location:** Port Hueneme, CA

Position Title	No.	Pay Rate	Overtime	Working Hours
5B31	1	GS-12	---	7:30 a.m. - 4:00 p.m
5D21	1	GS-7	---	6 a.m. - 2 p.m.
4C21	1	GS-11	---	6 a.m. - 3:30 p.m., every other Friday off
4Cxx	Many	GS-12	---	Varies
5A12	1	GS-12	---	Varies
Division Secretary	1/Div.	GS-5	---	Varies
Guard Mail Carrier	1	GS-5	---	7:30 a.m. - 4:00 p.m
4C00	1	GS-14	---	7:30 a.m. - 4:00 p.m

Figure B-2. *TMDER Processing* Workflow Personnel Information

TASK DEFINITION FORM

Task Name: Receive TMDER

Organizational Unit: NSDSA

Employee Position: Code 5B31

Location: Port Hueneme, CA

Description of the Work Performed:

Receive TMDERs and assign a TMDER case number
Log TMDER receipt
Determine who to route TMDER to based on TMDER deficiency comment

Governing Procedures	Controlling Entity	Date Issued
NAVSEA S0005-AA-PRO-010/TMMP	Naval Sea Systems Command	15 Aug. 1991

Can Work be Automated? Yes

Hardware and Software Required to Automate:

JCALS system tied to SALTS with ships

Better Way of Conducting Task: Tie PHD NSWC electronically with ships via SALTS onboard the ships and JCALS at PHD NSWC. Let the workflow tool in JCALS route an electronic version of TMDER for processing and response.

Frequency within Single Process Cycle: 1

Priority: High

Support/Core Activity: Core

When is Work Complete? When TMDER case number is assigned and logged.

Required Authorizations: None

Approving Entity:

Page 1 of 4

Figure B-3. *Receive TMDER* Task Definition Form Page One

TASK DEFINITION FORM

Work Object: TMDER			**# Copies** 1
Input	**Physical**	**Transmission Medium:** U.S. Mail	
Source Position: Fleet Unit		**Task:** N/A	
Format: NAVSEA Form 9086/10			**Automatable?** Yes

Work Object: TMDER			**# Copies** 1
Output	**Physical**	**Transmission Medium:** Hand Carry	
Destination Position: Code 5D21		**Task:** Determine if Technical	
Format: NAVSEA Form 9086/10			**Automatable?** Yes

Work Object: Forwarding Memo			**# Copies** 1
Output	**Physical**	**Transmission Medium:** Hand Carry	
Destination Position: Code 5D21		**Task:** Determine if Technical	
Format: Typed Memo			**Automatable?** Yes

Work Object:			**# Copies**
Input/Output	**Electronic/Physical**	**Transmission Medium:**	
Source/Destination Position:		**Task:**	
Format:			**Automatable?**

Page 2 of 4

Figure B-4. *Receive TMDER* Task Definition Form Page Two

TASK DEFINITION FORM			
Resources Consumed	**Form**	**Source Task**	**Source Entity**
2 Pages of Paper	Physical	N/A	N/A
Computer Word Processor	Equipment	N/A	N/A
Page 3 of 4			

Figure B-5. *Receive TMDER* Task Definition Form Page Three

TASK DEFINITION FORM

Decision/Question: Does TMDER Deficiency Require a TMDER Change?

Choice	**Result/Action**
Yes	Route TMDER to Code 5D21
No	Respond to Fleet Unit

Decision/Question:

Choice	**Result/Action**

Decision/Question:

Choice	**Result/Action**

Value Added to Final Product by Task Completion: Unknown

Page 4 of 4

Figure B-6. *Receive TMDER* Task Definition Form Page Four

<table>
<tr><td colspan="3">TASK DURATION WORKSHEET</td></tr>
<tr><td colspan="2">Task Completion Time: 90 Minutes</td><td rowspan="2">Transfer Times
Incoming Work Object: N/A
Outgoing Work Object: Approx 15 mins.
Total Transfer Time: 15 Mins.</td></tr>
<tr><td colspan="2">Queue Time: None</td></tr>
<tr><td>Other Delay Time:
2 Days</td><td colspan="2" rowspan="2">Reason for Delay:
TMDERs for PHD NSWC are held and forwarded together to PHD NSWC only two times per week.</td></tr>
<tr><td>Total Task Duration:
2 Days and 105 mins.</td></tr>
</table>

Figure B-7. *Receive TMDER* Task Duration Worksheet

PROCESS PERFORMANCE FORM Process: TMDER Processing				
Performance Measure	**Goal**	**Alternative A**	**Alternative B**	**Alternative C**
Reduce Cycle Time	Any	-1,505	- 0	No Change TMDER
		-3,075	-1,250	Technical TMDER
		-2,875	-1,050	Non-Tech. TMDER
Reduce Cost	Any	-$ 41.66	-$ 0.00	No Change TMDER
		-$164.91	-$ 76.54	Technical TMDER
		-$118.84	-$ 30.47	Non-Tech. TMDER
Page 1 of 1				

Figure B-8. *TMDER Processing* Process Performance Form

APPENDIX C. PHD NSWC WORKFLOW DIAGRAMS

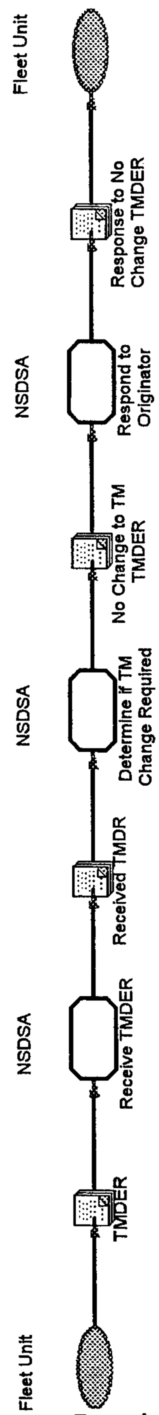

Figure C-1. No Technical Manual Change Required TMDER Workflow

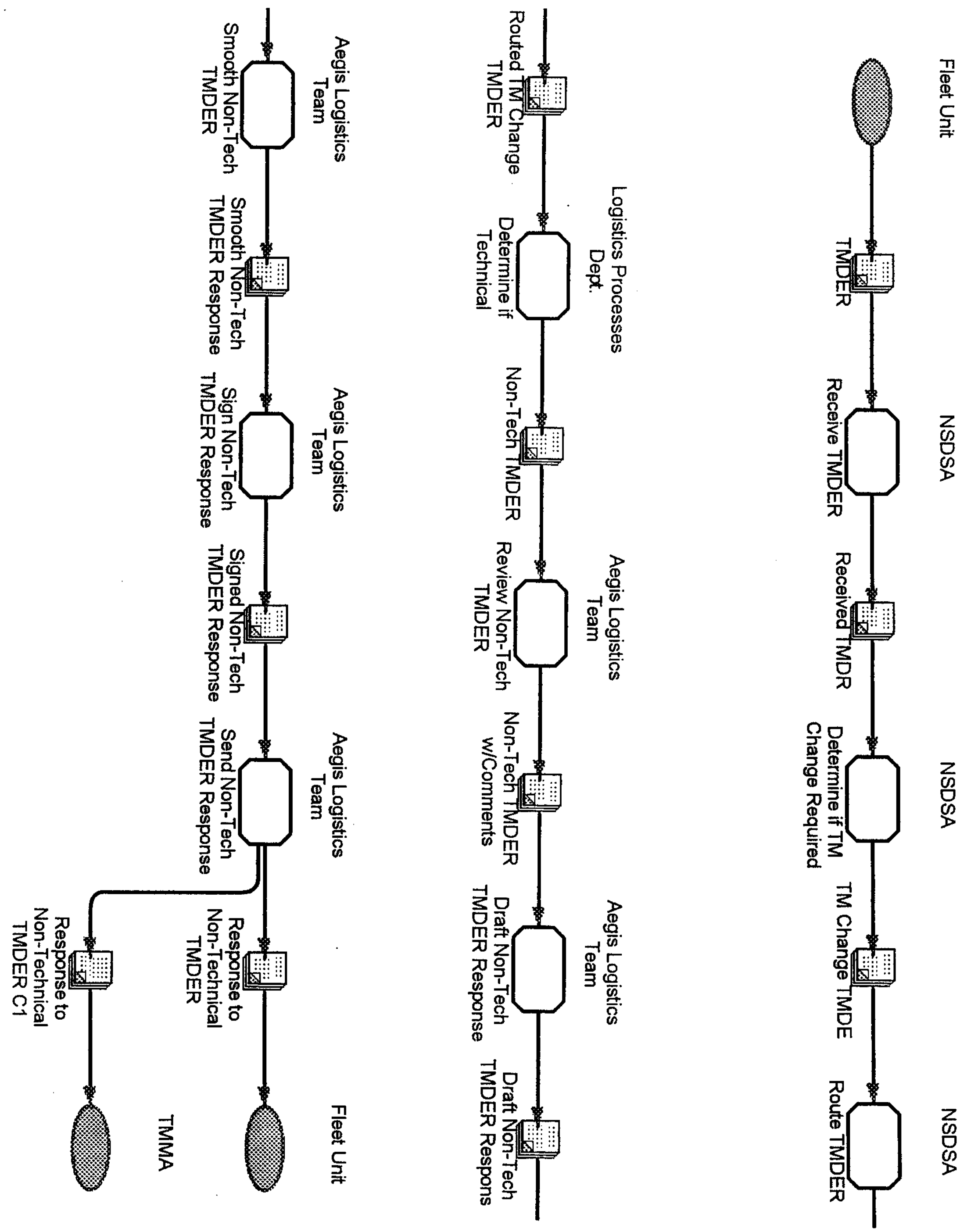

Figure C-2. Non-Technical TMDER Workflow

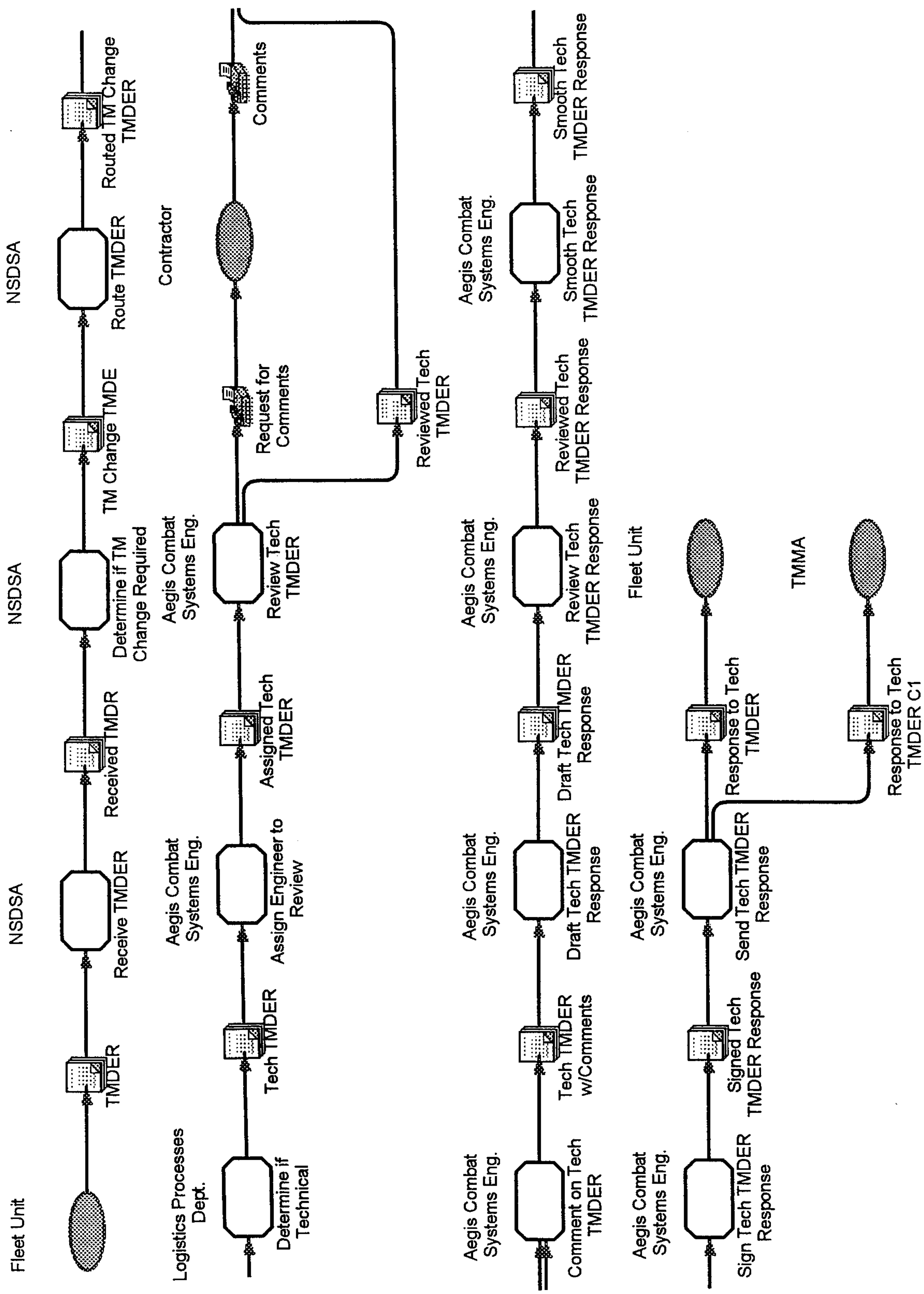

Figure C-3. Technical TMDER Workflow

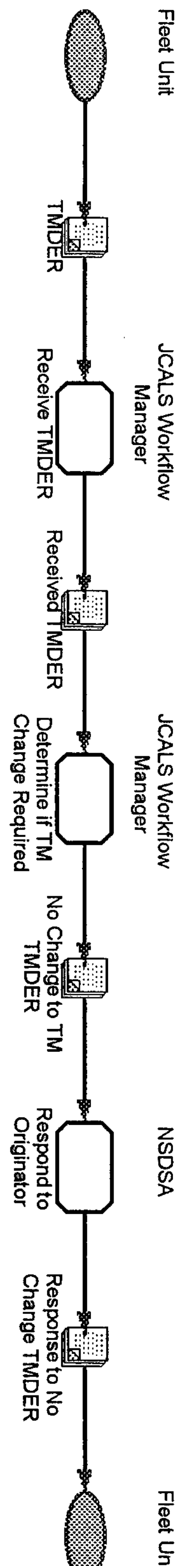

Figure C-4. Alternative A, No Technical Manual Change Required Workflow

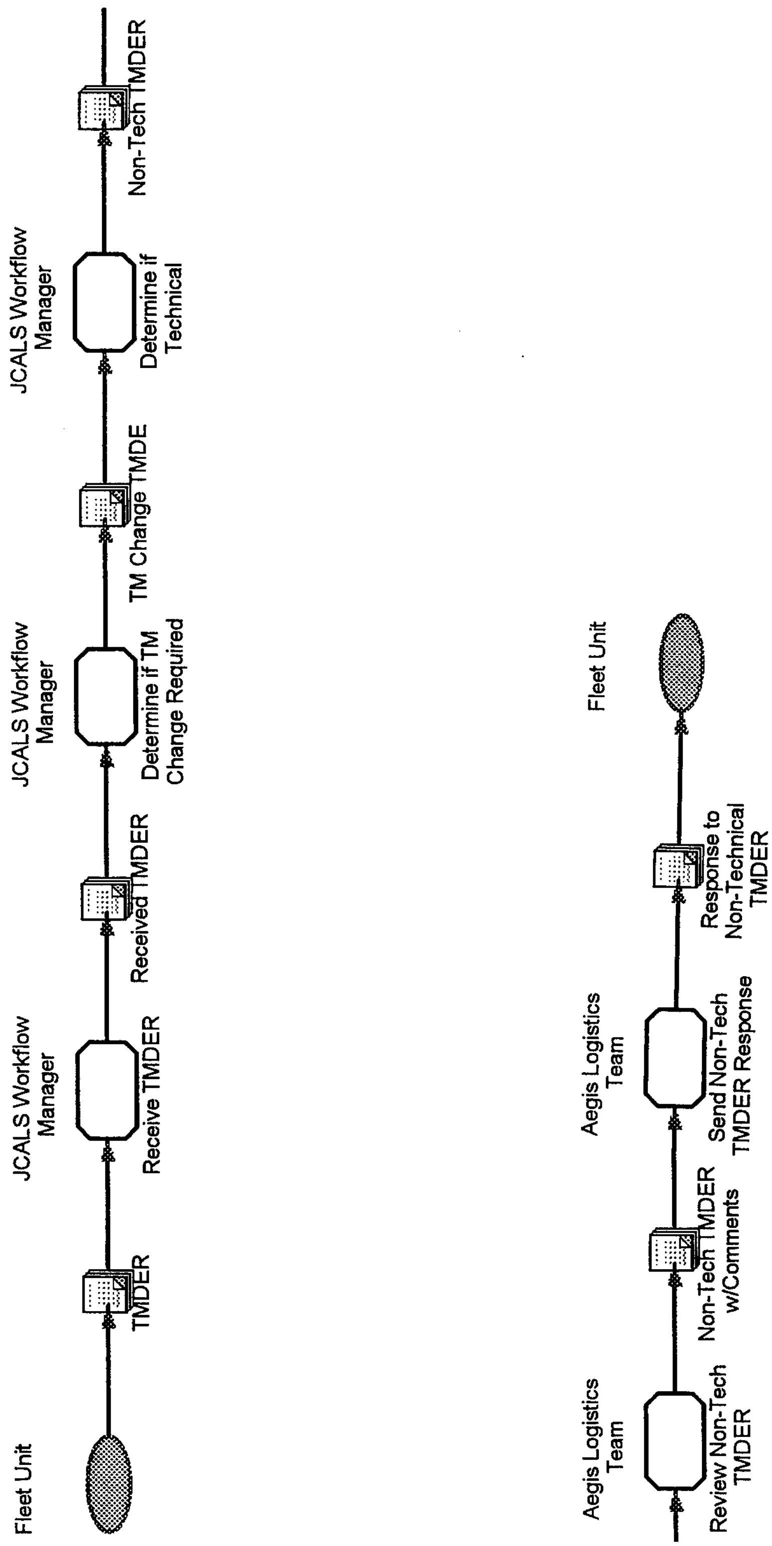

Figure C-5. Alternative A, Non-Technical TMDER Workflow

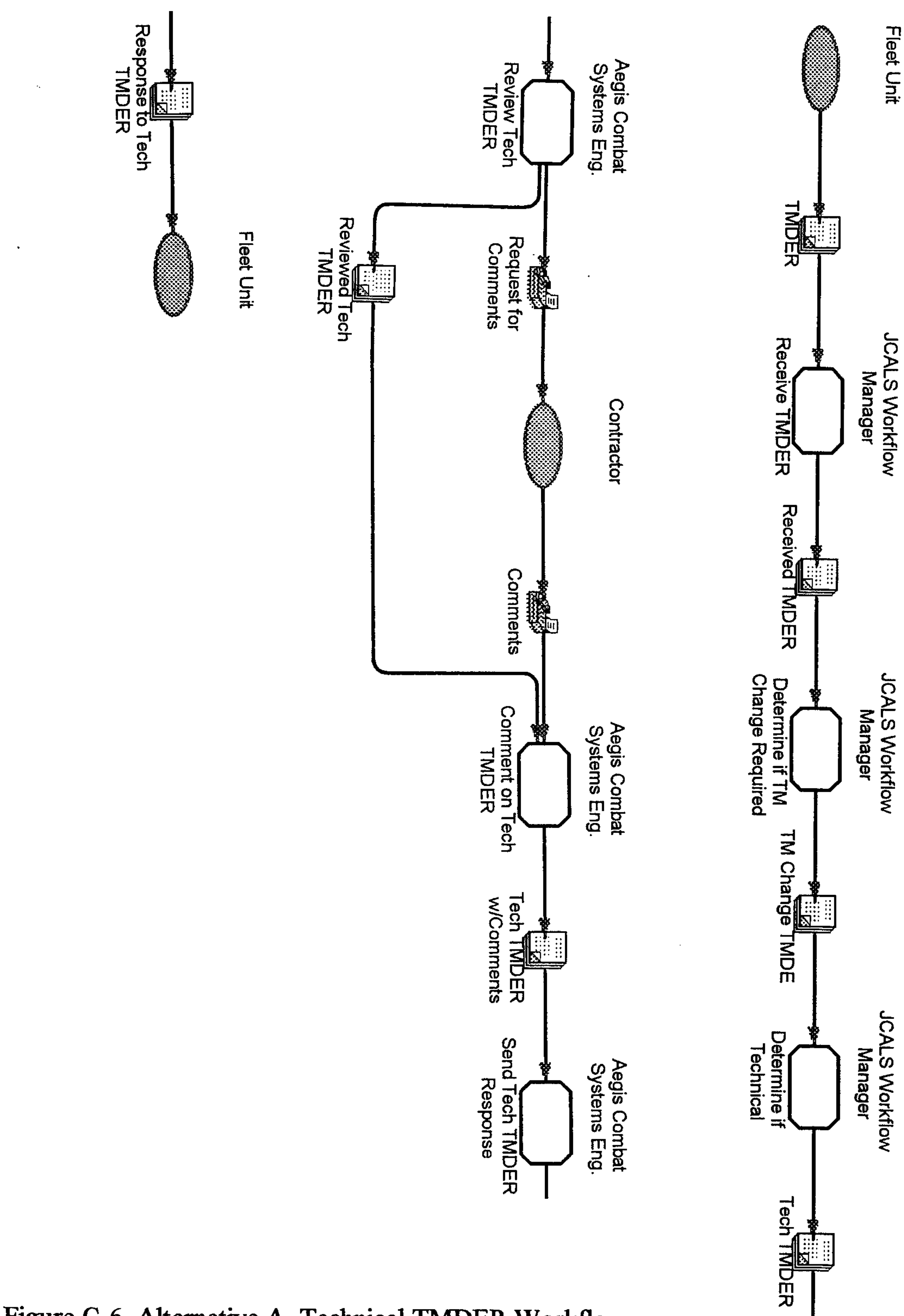

Figure C-6. Alternative A, Technical TMDER Workflow

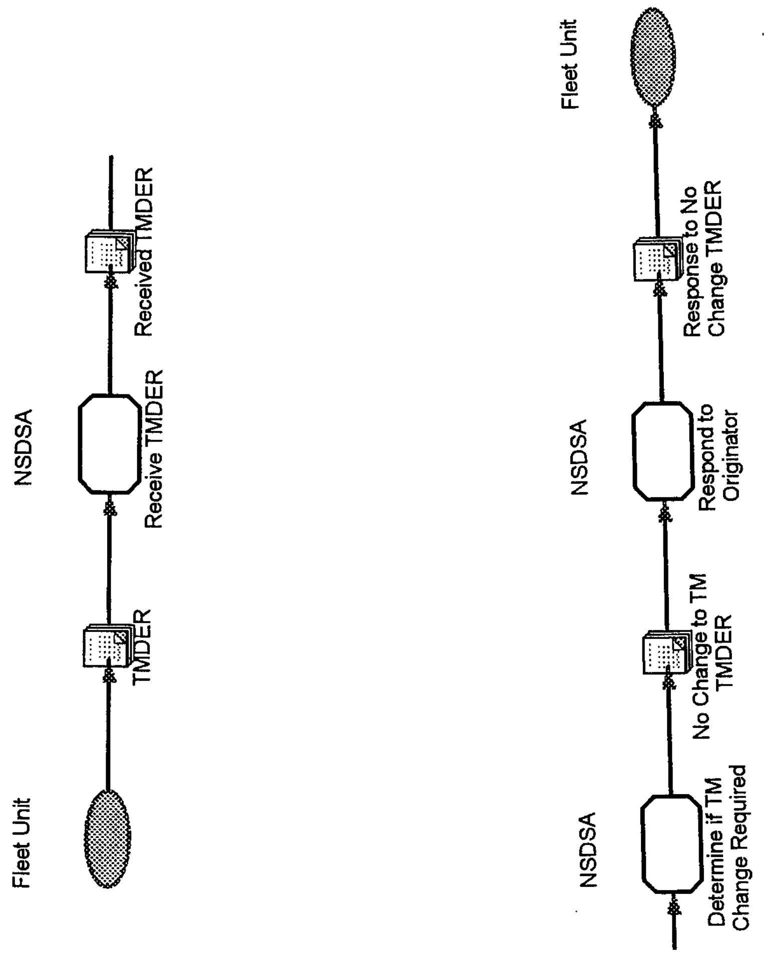

Figure C-7. Alternative B, No Technical Manual Change Required Workflow

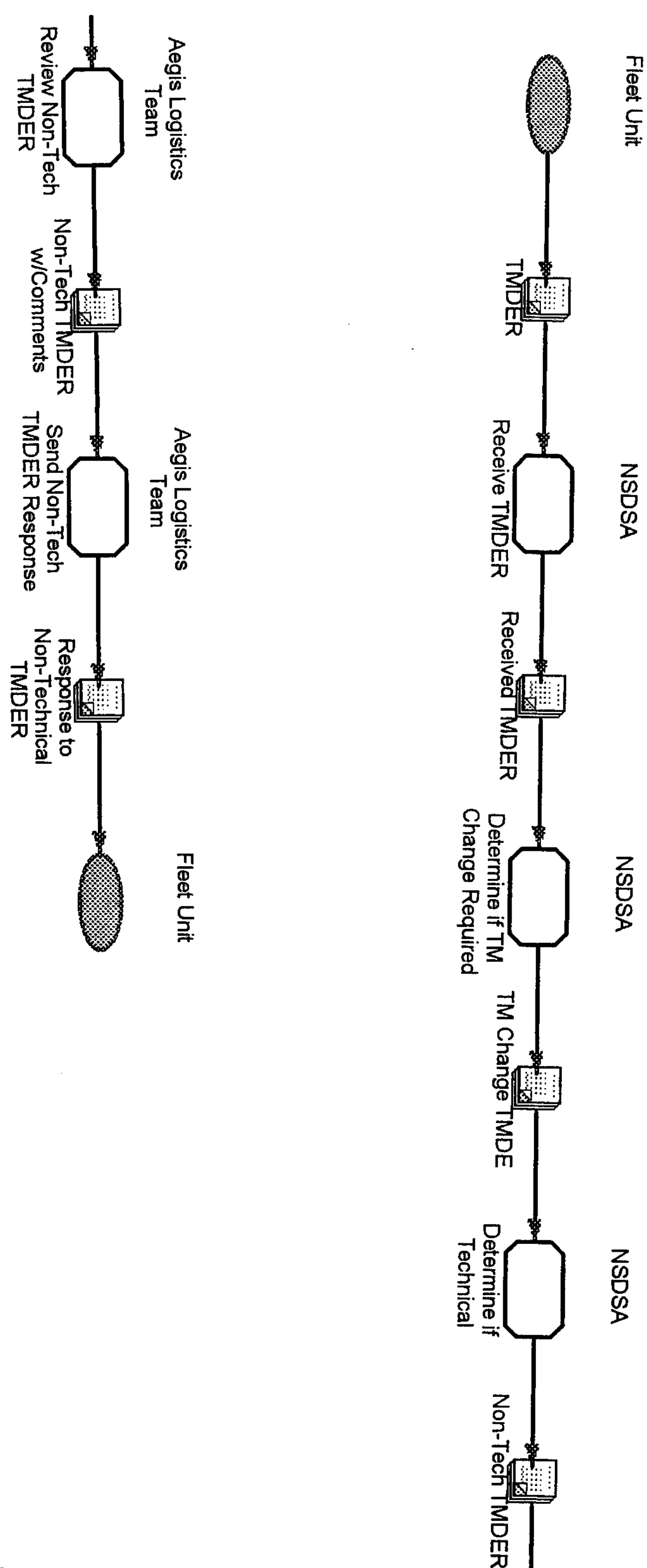

Figure C-8. Alternative B, Non-Technical TMDER Workflow

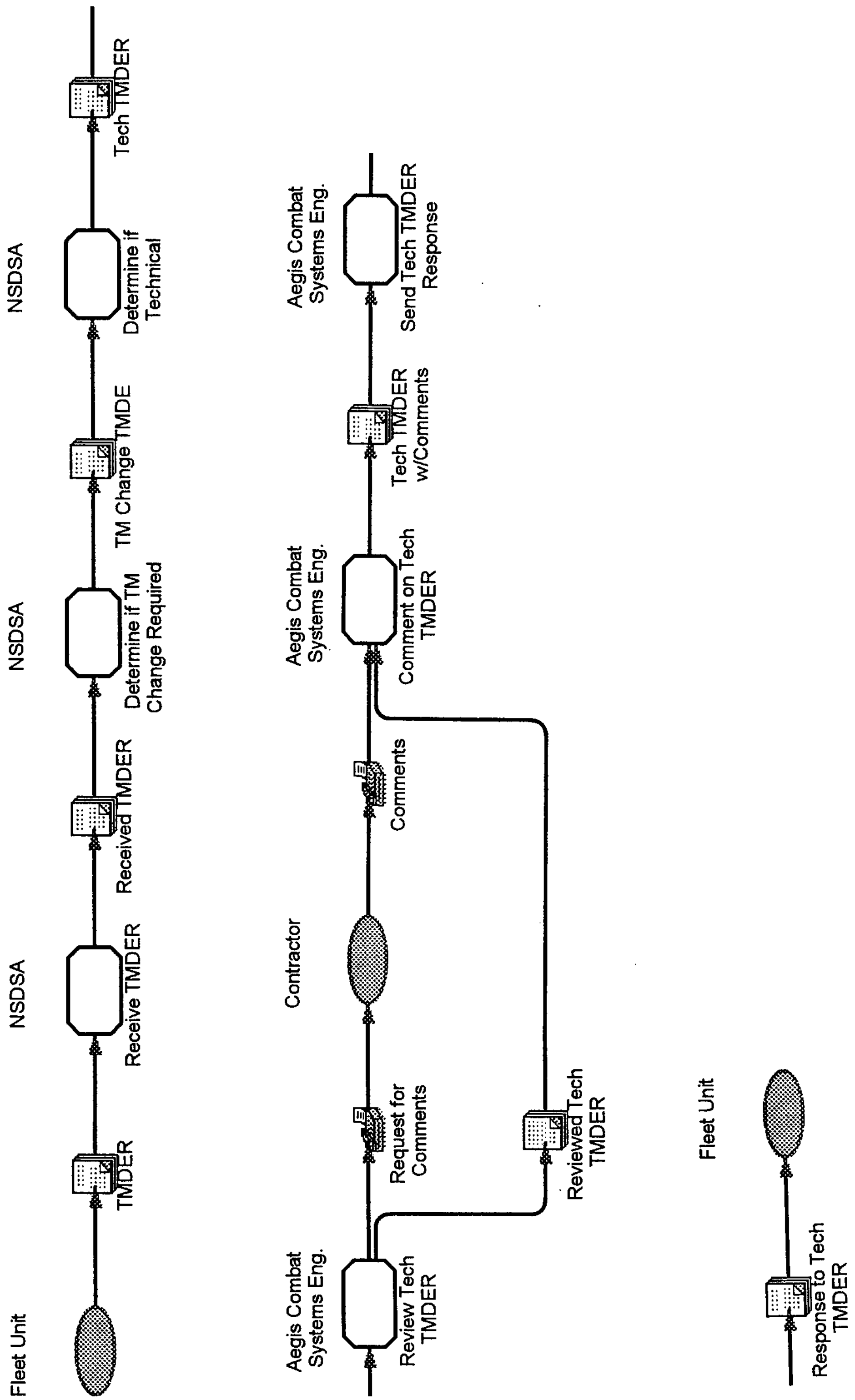

Figure C-9. Alternative B, Technical TMDER Workflow

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